ENGINEERING AND

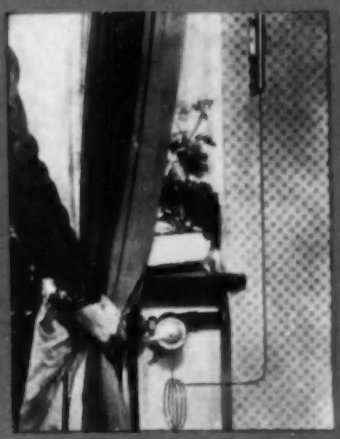
BOILER HOUSE REVIEW

ESTABLISHED 1899

& SIXPENCE

VOL. 75 NO. 2 • THE PIONEER STEAM JOURNAL • FEBRUARY, 1960

Normal design with fixed phial.



Special design with capillary tube and loose phial, which can be used where the natural air circulation is checked.

Special design for covered radiators.

Do it with

Danfoss

thermostatic radiator valve

- Great sensitivity
- Economical operation of the plant
- Easy operation
- No stuffing box
- Phial unit can be interchanged without draining of the system
- Will prevent freezing
- Temperature range between 37.4° F. and 77° F.

The Danfoss Thermostatic Radiator Valve is provided with an adjustable temperature scale and is constructed so that each radiator is regulated separately. It can be used for all central heating plants and gives a new feeling of comfort as well as a considerable saving of fuel.

With a Danfoss Thermostatic Radiator Valve you determine the temperature.

Write for the brochure Q 13-002 containing detailed information.

everything under Danfoss control

DANFOSS AUTOMATIC CONTROLS AND EQUIPMENT
13, Queensway, London, W.2. Telephone BAYswater 9321

SAVE FUEL

A simple and lasting solution. It is a question of getting the fuel to go as far as possible.

STEIN Refractories

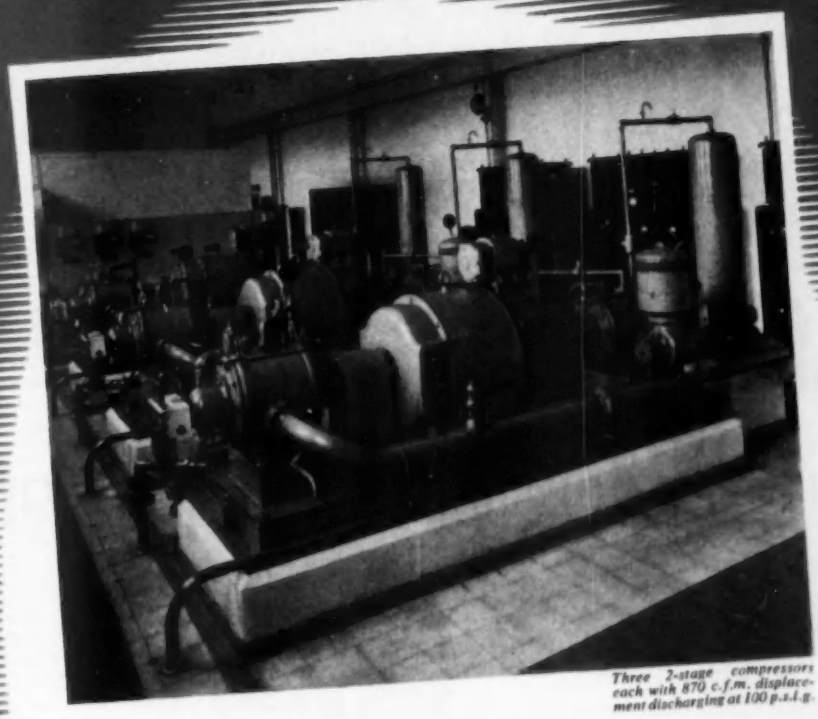
REFRACTORY CONCRETES

are finding increasing applications in all manner of furnace constructions. Our illustration is of a soaking pit cover where a very useful life is regularly obtained using Stein Refractory Concrete. We can offer a range of Refractory Concretes for use up to 1800°C—See technical data below:—

	How supplied	Refractoriness	Type of Set	Thermal Hardening Temperature	Maximum Temperature of Use	Lbs./Cub.Ft.
Stein Refractory Concrete	Dry	1420°C	Hydraulic	1200°C	1350°C	120
Stein Super Refractory Concrete No. 16	Dry	+1750°C	Hydraulic	1200°C	1600°C	160
No. 17	Dry	+1750°C	Hydraulic	1200°C	1700°C	160
No. 18	Dry	+1750°C	Hydraulic	1200°C	1800°C	160
Stein Chrome Concrete	Dry	+1750°C	Hydraulic	1200°C	1500°C	180

JOHN G. STEIN & CO. LTD. Bonnybridge, Scotland

TEL.: BANKNOCK 255 (4 LINES)



Three 2-stage compressors each with 870 c.f.m. displacement discharging at 100 p.s.i.g.

Rotary Compressors and Vacuum Pumps

The Hick Hargreaves Rotary Compressor is of the eccentric rotor type, with sliding steel blades which are prevented from making contact with the cylinder walls by restraining rings. High rotational speeds can thus be achieved without great frictional losses. Hick Hargreaves Rotary Compressors have many other advantages—easy and cheap installation; retention of initial high performance; regular air flow and low noise level; easy maintenance due to the absence of moving valves, and the reduction of wear to a minimum by the use of roller bearings.

A comprehensive range of both single and two stage compressors and vacuum pumps is available with capacities up to 2,000 c.f.m.

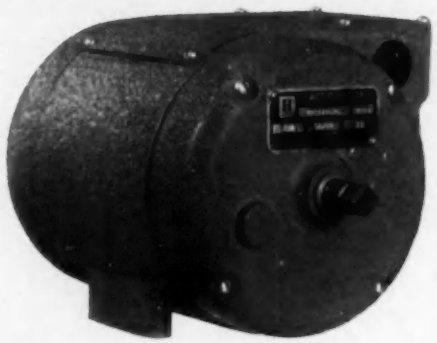
Hick Hargreaves

AND COMPANY LTD · BOLTON

H.138B

A

New



Type A Actionator motors are ideal for rotary plug valves, dampers, butterfly valves, etc.
Features include internal brake and micro switch limit switches.

ACTIONATOR

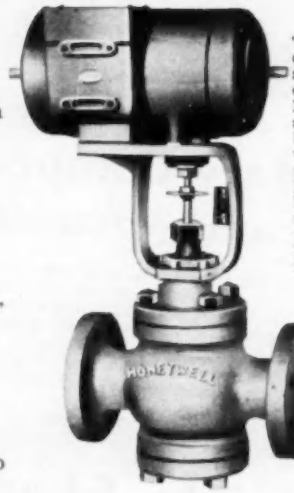
heavy duty electric motors for valves and dampers

Use the powerful new Actionator industrial type motors to operate slip stem valves, rotary plug valves, butterfly valves, dampers, etc.

Variety of speeds
Actionator motors are available with a variety of speeds, from 9 to 144 seconds full-stroke operation. The high speed permits use with pulse-type controllers such as those used in radiant tube firing. Torque ratings range to 200 lb-inches.

All control forms
Models are available with two-position, floating and proportional control. Optional models can include cam-operated, internally mounted switches for a variety of dual switching purposes.

Write Now
for more details, or send the coupon to Honeywell Controls Limited, Ruislip Road East, Greenford, Middlesex. WAXlow 2333. Branch offices in principal towns and cities of the United Kingdom —and throughout the world.



Type B Actionator motors are designed for vertical acting slip stem valves having lifts of ¼ inch through 1¼ inches. Double ended shaft can also simultaneously operate butterfly valves, rotary stem valves and other devices through suitable linkages. Features include built-in linkage and strain relief, mounting yoke and enclosed terminals with gasketed housing. No auxiliary mounting bracket required.

Honeywell
First in Control
SINCE 1885

Please send me a copy of:
Specification Sheet S804-3 (Type A) ☐
Specification Sheet S1016-2 (Type B) ☐

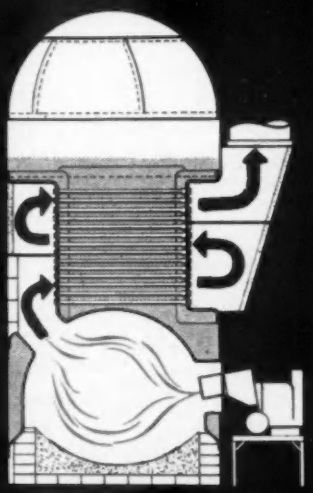
NAME .....

POSITION .....

ADDRESS .....

..... E.B.H.R.

the VERTICAL Vogue



This neat and well established vertical profile gives assurance of complete satisfaction. Reliability coupled with the latest devices giving completely automatic control and a highly efficient performance meets every requirement.

The vital statistics of Series II will interest you, for instance a guaranteed efficiency of over 80% on the gross calorific value of the fuel, fully automatic controls, oil-fired yet convertible to solid fuel, having generous steam space, being fully tested and set before despatch.

All this without sacrificing the essential design features of Cochran Vertical Boilers which have, over the years, shown supreme qualities of reliability and durability. Vertical Boilers require the minimum of space.

Series II boilers are available in ratings from 1,750 to 10,000 lbs. per hour from and at 212°F.

A Series II under test. Special lagging covered with steel sheeting, banded in position, completes the finish at site.

THE NEW COCHRAN *Series II*

COCHRAN & CO., ANNAN, LIMITED, DUMFRIESSHIRE, SCOTLAND, ANNAN 111
and at 34 VICTORIA STREET, LONDON, S.W.1. ABBEY 4441

TAS (H) 672

take NEWTHERM on test!

Test its STRENGTH

NEWTHERM is unusually strong and rigid—a feature of special importance in the larger, more vulnerable sections. Put a sample section or slab on part of your plant and *prove for yourself* its outstanding ability to withstand impact and water damage. See how it withstands rough handling in transit and erection, minimising breakage in shipment and erection by unskilled labour at the most remote sites.

Test its MOISTURE RESISTANCE

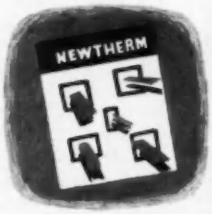
Even totally immersed in water, NEWTHERM retains much of its strength and rigidity. It does not become deformed when in contact with water, thus work-in-progress need not be covered. Especially on contracts where weather conditions would delay the application of insulation—NEWTHERM is the material to use.

Test its LIGHTNESS

Unusually light for such a high-efficiency material, NEWTHERM compares favourably in this respect with other insulants far inferior in strength. That means easier handling and fewer breakages—even the largest section is easily carried in one hand.

Test its EASE OF APPLICATION

Undoubtedly, NEWTHERM is one of the easiest of materials to apply. It is supplied in plastic form and in a wide range of standard-sized sections and slabs, smoothly finished and straight edged for immediate fitting. The finished job is very neat, with minimum joints, and appliers particularly appreciate the handleability of the material – especially in difficult situations.



READ ALL ABOUT NEWTHERM

in a specially prepared booklet. Sizes, compressive strength, thermal conductivity,—this and much more useful information can be on file if you write for your copy now, to the sole manufacturers Newalls Insulation Co. Ltd

NEWALLS (Reg'd Brand)

***NEWTHERM** calcium silicate insulation*

. . . for temperatures up to 1400°F.

NEWALLS INSULATION CO. LTD.

Head Office: WASHINGTON, CO. DURHAM, ENGLAND.

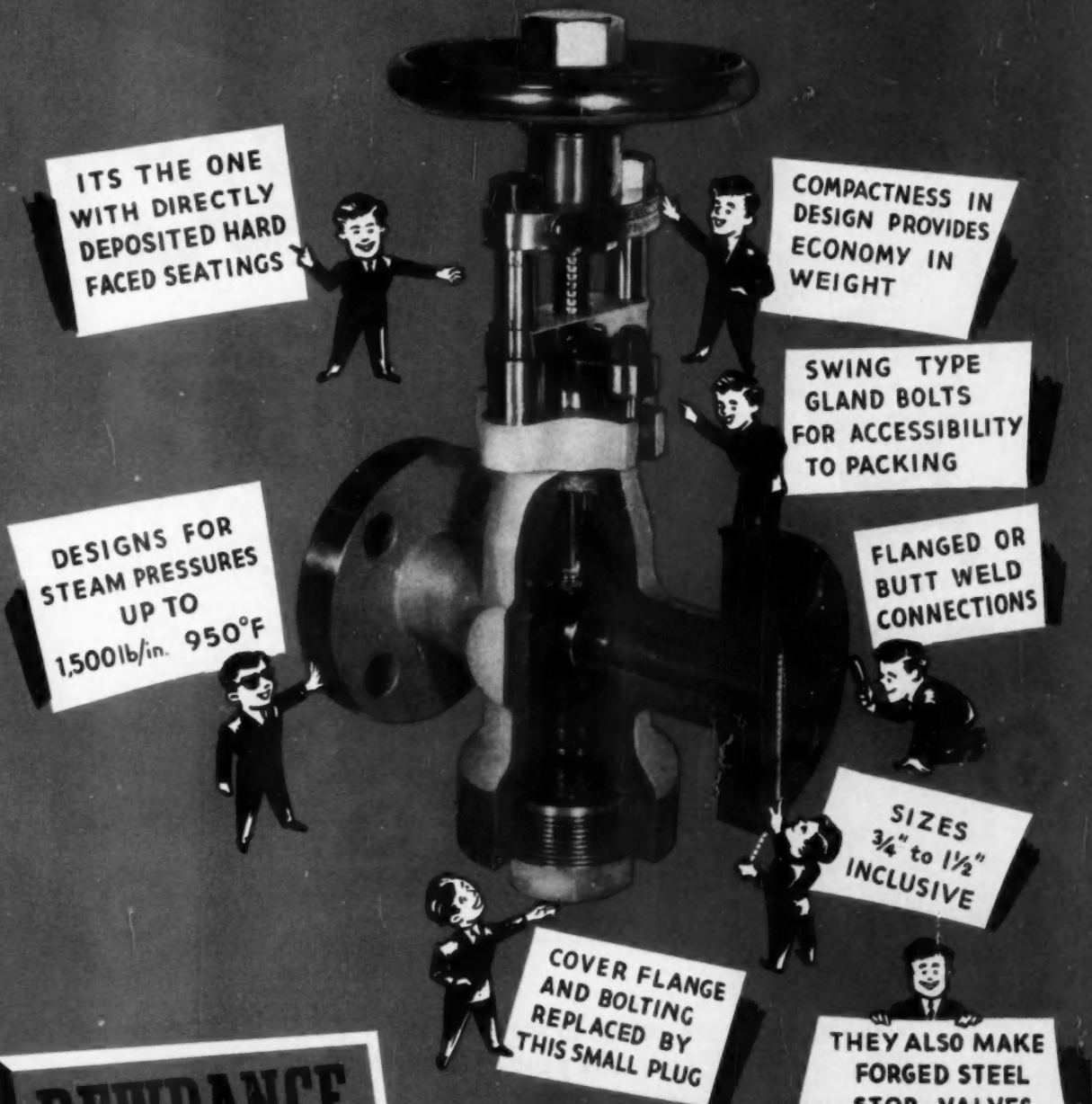
A member of the TURNER & NEWALL ORGANISATION

Offices & Depots at: LONDON, GLASGOW, MANCHESTER, NEWCASTLE UPON TYNE, BIRMINGHAM, BELFAST, DUBLIN, BRISTOL & CARDIFF.

Agents and Vendors in most markets abroad.

For the most severe service conditions

Install **DEWRANCE** **FABRICATED PARALLEL SLIDE VALVES**


ITS THE ONE WITH DIRECTLY DEPOSITED HARD FACED SEATINGS
COMPACTNESS IN DESIGN PROVIDES ECONOMY IN WEIGHT
SWING TYPE GLAND BOLTS FOR ACCESSIBILITY TO PACKING
DESIGNS FOR STEAM PRESSURES UP TO 1,500lb/in. 950°F
FLANGED OR BUTT WELD CONNECTIONS
SIZES ¾" to 1½" INCLUSIVE
COVER FLANGE AND BOLTING REPLACED BY THIS SMALL PLUG
THEY ALSO MAKE FORGED STEEL STOP VALVES NON-RETURN VALVES MONOWAY VALVES

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AND COMPANY LTD.

GREAT DOVER STREET,
LONDON, S.E.1.

TELEPHONE: HOP 3100 (12 lines)

WORKS: LONDON · BRADFORD · DUMBARTON · HILLINGTON

Safe

Conduct

A PLESSIFLEX application on the Bristol Bloodhound

Tough, flexible, seamless, all-metal PLESSIFLEX is the most thoroughly reliable means of conveying fuels and chemicals – whether they are gases or liquids, very hot or very cold, corrosive or inflammable - from one place to another. And this point is overwhelmingly endorsed by engineers in the aeronautical, nuclear, marine and chemical industries.

At pulsing pressures, at high pressures or under vacuum conditions, PLESSIFLEX provides the vital link between those parts in your installations which are subject to continual relative movement.

The basic components of PLESSIFLEX are the result of continuous development and testing, in consequence of which the complete hose units are unrivalled in their high quality. Offered in a range of sizes from ¼″ to 2½″ bore, and in almost any metal you care to name, PLESSIFLEX may be tailored to *your* particular requirements.

Suitably braided for stability, the tube itself is made from material that has been subjected to rigorous pre-process analysis – everything in fact about this versatile, incredibly robust product is shaped to the ends of higher performance and greater safety in fields where such requirements are essential.

Our engineers are waiting to show you how can solve your piping problems

PLESSIFLEX
Regd. Trade Mark

POWER AUXILIARIES LIMITED

Kembrey Street · Swindon · Wilts · Tel: Swindon 6211

Overseas Sales Organisation – Plessey International Limited, Ilford, Essex. Tel: Ilford 3040

PAL 14D.

COAL-Mechanical Stokers

and the

CLEAN AIR ACT

As recently announced in the press, a new ministerial order permits the installation of mechanical coal burning equipment in Smoke Control Areas. It follows that the most modern and efficient plant should, of course, be installed on the lines of the latest Hodgkinson boiler house equipment.

"METERFEED" UNDERFEED STOKER

This stoker has separate drive and fan motors which our "Custodian" Panel controls by cutting in the fan at a predetermined period before the drive and cutting out the fan after the drive has stopped.
The "Meterfeed" Underfeed Stoker is designed for the utmost fuel economy **without smoke** and is available in a full range of sizes in both hopper and bunker feed models and suitable for boiler, kiln and furnace application. All models embody the controlled feed principle.

NEW "CUSTODIAN" CONTROL PANEL

The combination of the "Custodian" panel with the "Meterfeed" Underfeed Stoker operates as a highly efficient guarantee against the production of smoke and its consequences under the Clean Air Act.

NEW HODGKINSON 8" UNIVERSAL COAL ELEVATOR

- ★ *Entirely new concept of simple design*
- ★ *Elevates at any angle between 60° and vertical*
- ★ *Easy assembly in a matter of hours*
- ★ *Many new features incorporated*
- ★ *Low initial cost and low maintenance*

The elevators in this range are made up from standard parts available from stock.

JAMES HODGKINSON

(SALFORD) LTD.

Ford Lane Works, Pendleton, Salford, 6, Lancs. Tel: PENdleton 1491

Brettenham House, Lancaster Place, Strand, London, W.C.2. Tel: COVent Garden 2188

PERMUTIT WATER TREATMENT

All Boilers need Good Feedwater

THE CONTROL PANEL on the opposite page does an important job at the Carrington Works of Messrs. Shell Chemicals Limited: it controls the fully automatic Permutit plant producing nearly a million gallons daily of very pure water for high pressure boilers.

This and similar plants supplied recently by Permutit emphasize the vital importance of correct boiler feed treatment, not only for highly rated steam generators, but also for boilers working at medium and low pressures.

In the extreme pressure range, the only tolerable feedwater is one free from dissolved solids, with almost unmeasurable silica and an electrical conductivity of less than 0.5 micromhos per cm3. Water to this high standard is produced cheaply, in any quantity, by "Deminrolit" mixed bed ion exchange plant.

For intermediate pressures, the feed must be completely free from scale-forming matter, with controlled alkalinity and reduced dissolved solids. Partial demineralising by the Permutit "Starvation"-Base Exchange process produces make-up of this type.

With boilers used for heating or low process steam production, scale on any of the heating surfaces or in economizers and pre-heaters wastes fuel and increases the cost of maintenance. The feed must therefore be zero soft: this is ensured by Permutit Base Exchange softening.

To eliminate dissolved gases from feed water and prevent corrosion, the Permutit de-aerator — operating with exhaust steam — reduces oxygen to less than 0.005 cc's per litre.

For low running costs, easy maintenance and consistent steam production, boilers need the best possible feed water. Selecting the plant to give the right treatment is a specialist's job that can be safely left to Permutit.

BY APPOINTMENT
SUPPLIERS OF WATER
TREATING EQUIPMENT
TO THE LATE KING GEORGE VI

For technical information on boiler feed treatment write to:—

THE PERMUTIT COMPANY LIMITED

DEPT. T.H.1, PERMUTIT HOUSE, GUNNERSBURY AVENUE, LONDON, W.4

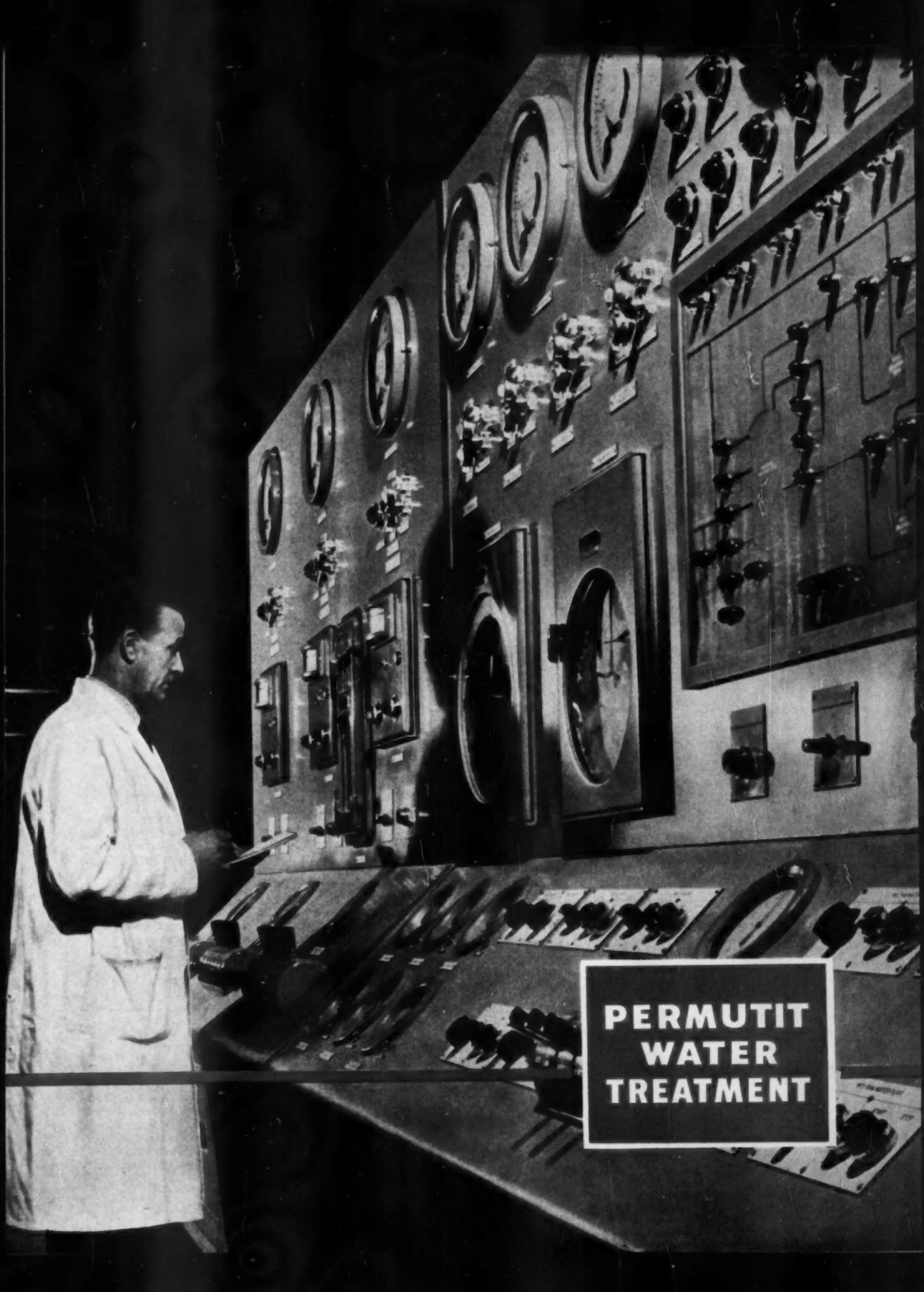
TELEPHONE: CHISWICK 6431 WORKS: EALING AND SOUTH WALES CABLES: PERMUTIT, LONDON

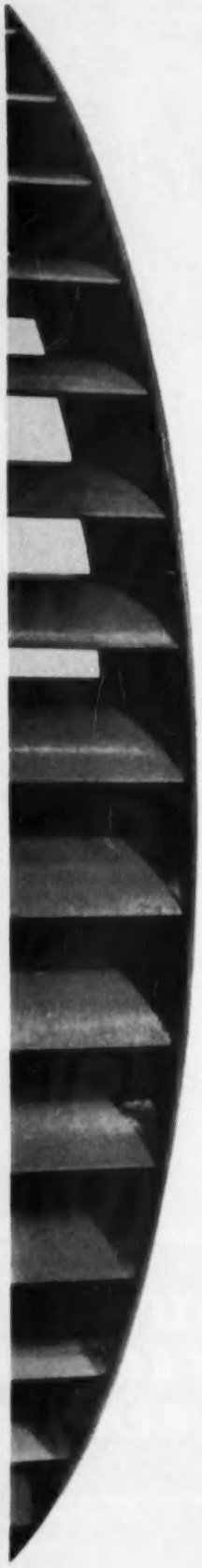
SUBSIDIARY COMPANIES

THE PERMUTIT COMPANY OF AUSTRALIA PTY LIMITED
567-573 Pacific Highway, Crow's Nest, Sydney, N.S.W.

THE PERMUTIT COMPANY OF SOUTH AFRICA (PTY) LTD.
P.O. Box 6937, Johannesburg.

ION EXCHANGE (CANADA) LTD. 33 Price Street, Toronto 5, Ontario


PERMUTIT
WATER
TREATMENT



formula for leadership

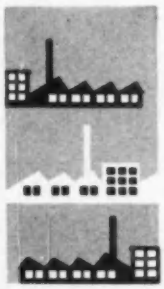
Experience Founded originally in 1823 the Company has had the widest experience in the design and manufacture of all types of equipment for the handling of air and other gases. Blowers, exhausters, heaters, filters, dust and fume removal equipment, and of course, fans of all types, fall within this wide scope. Fans of every size and for every purpose, from Coal Mines to Aircraft Carriers, have been designed, manufactured and tested by Keith Blackman and installed in all parts of the world—experience unparalleled in the field.

Range The Keith Blackman range covers virtually every type of fan and blower in all sizes—axial types from 5 inch to 100 inch diameter, centrifugal types ranging from 1¼ inch to 180 inch, and propeller fans from 6 inch to 72 inch diameter. Many are designed for special applications and in special materials including pvc. Other equipment is made for heating, cooling, washing, dust and fume extraction, filtration and air conditioning. *Five thousand fans of varying types are kept continuously in stock for quick delivery.*

Research Keith Blackman's lead in design is maintained by five separate research departments. Specialised facilities are available at Tottenham for the development and testing of axial fans, centrifugal fans and filtration equipment, while a metallurgical laboratory controls the quality of materials founded at Arbroath. Tottenham also possesses one of the most advanced acoustics laboratories in the world for the investigation of sound levels in all types of fan engineering equipment.
In addition, the company's generating station, as well as supplying power to the factory, is designed to produce a wide range of A.C. and D.C. supplies for the test beds.

Keith Blackman Ltd
(Incorporating Blackman Export Co. Ltd.)
MILL MEAD ROAD, LONDON N.17 TOTTENHAM 4522

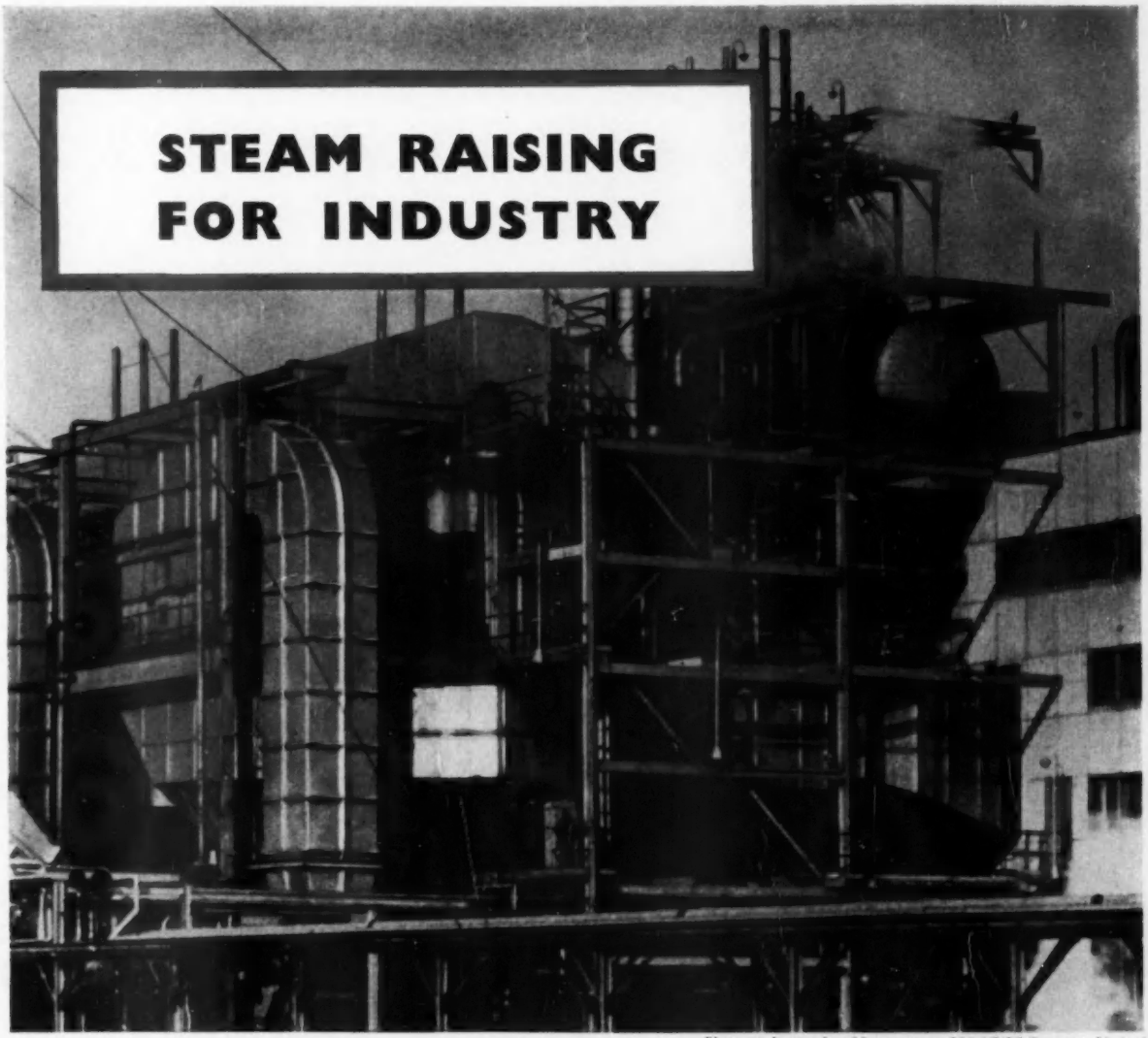
Leaders in the Fan Industry



Resources The company's three factories cover an area of 17¼ acres, and employ over 1,800 people. The main Tottenham works produces small and medium units and includes drawing offices, test facilities and machine shops, as well as the sales and administration offices.
The Arbroath works deals with the production of the larger fans. Its iron and non-ferrous foundry plant supplies the whole of the company's casting needs.
The Edmonton Factory concentrates on light sheet metal and plate work and the fabrication of steel structures.
Virtually all components, including fan motors and bearing housings, are thus designed and manufactured within the organisation—a unique combination of resources.

Service Through the years the company has built up an enviable reputation for service at all stages. Sales representatives are all fully trained technical men capable of giving 'on the spot' advice on routine applications or special problems. The sales organisation operates from branches throughout the country backed by a staff of qualified sales engineers at Head Office.
Despatch of stock items, of which 5,000 units are kept continuously available, is possible in as little as four days. The Company has its own road transport fleet and direct rail connections from the main factory.

TA2545/1040



Photograph reproduced by courtesy of Mobil Oil Company Limited

MOBIL OIL COMPANY LTD, CORYTON REFINERY

3 boiler units each producing 180,000 lbs/hr. at 615 p.s.i. 750°F

INTERNATIONAL COMBUSTION build boilers to suit the individual steam raising requirements of every industry. Whatever the problem, IC steam generating equipment ensures the best use of fuel resources.

WATERTUBE BOILERS FOR OIL, GAS OR SOLID FUEL FIRING

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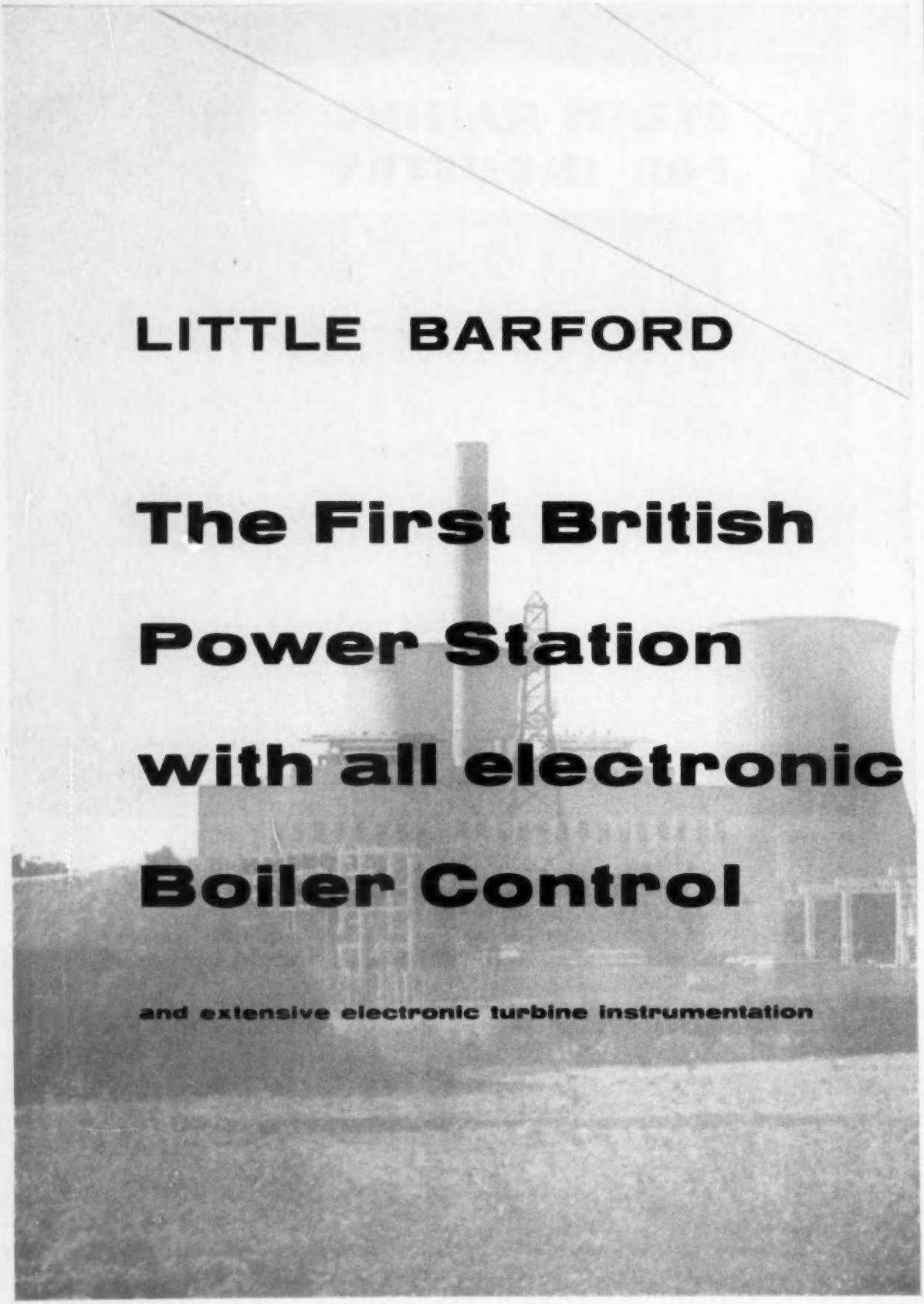
Member of Atomic Power Constructions Ltd. One of the British Nuclear Energy Groups

TGA 1814

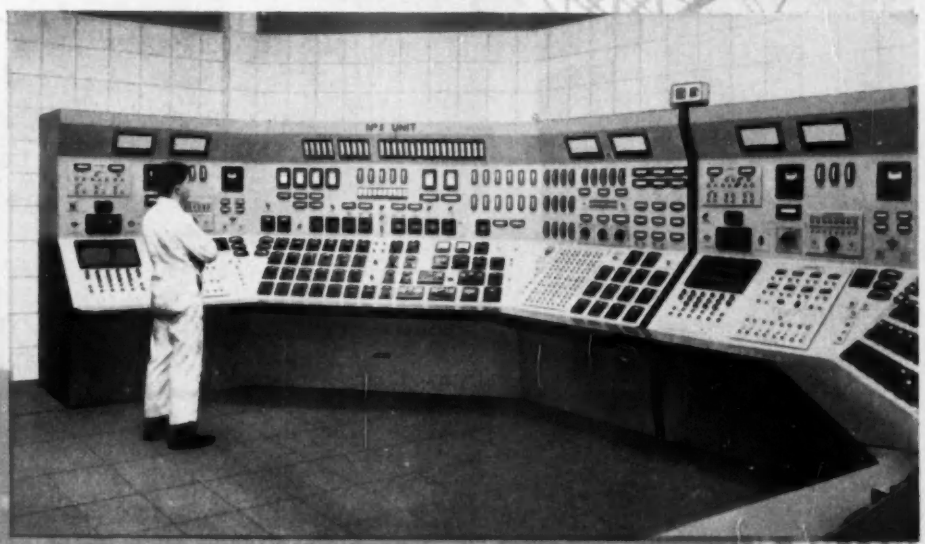


LITTLE BARFORD

The First British Power Station with all electronic Boiler Control

and extensive electronic turbine instrumentation

The first power station in the world to be controlled electronically was in Newfoundland using Evershed equipment. Other Evershed installations followed rapidly at Calgary, Wabamun, Vancouver, and now the first in this country—Little Barford. This major contribution to industry includes the provision of electronic transmitters, process controllers, analogue computers and electro-hydraulic positioners, indicators and recorders, plus the know-how of experienced engineers backed by a large and world famous organisation.



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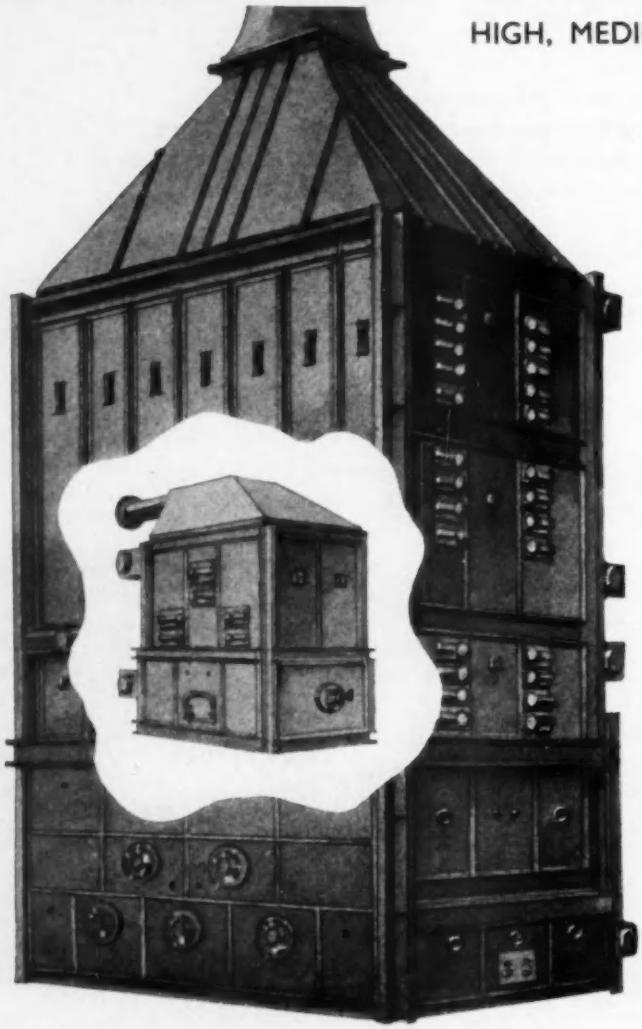
FOR DISTRICT HEATING and INDUSTRIAL PLANT REQUIREMENTS

LA MONT HOT WATER BOILERS

HIGH, MEDIUM and LOW PRESSURES



LA MONT Hot Water Boilers are installed for a wide range of capacities and conditions. Illustration shows comparative size of oil-fired boiler for capacity of 70,000,000 Btu./Hr. with 2,000,000 Btu. boiler inset to the same scale.

LA MONT Hot Water Boilers are the most efficient, flexible and compact units available for industrial heating and district heating requirements.

Suitable for coal, oil, creosote pitch or gas firing and for utilising the waste heat in flue gases from all kinds of industrial processes.

LA MONT STEAM GENERATOR LIMITED

HEATHER PARK DRIVE, WEMBLEY, MIDDX.

Telephone: WEMBLEY 8821

MY MIND IS MADE UP.!

Don't confuse me with the Facts . . .

My dad always used loops . . .
I tried bellows once, in 1925 . . .
failed, of course . . .

I always let the whole pipe ride . . .

Take up 28" expansion at one point?
Don't believe it!

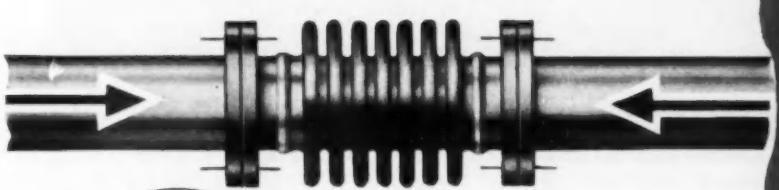
½ Ton thrust on pipe anchors at 500 psi?
Impossible!

5'-0" and 5'-6" diameter at
Three Atomic Power Stations?
What good's that to me?

Quick delivery?
Never quick enough!

Manufacturing over 60 years?
You've hardly started!

Complete Information available?
Think I'm interested?



IWK COMPENSATORS

ENGINEERING APPLIANCES LIMITED

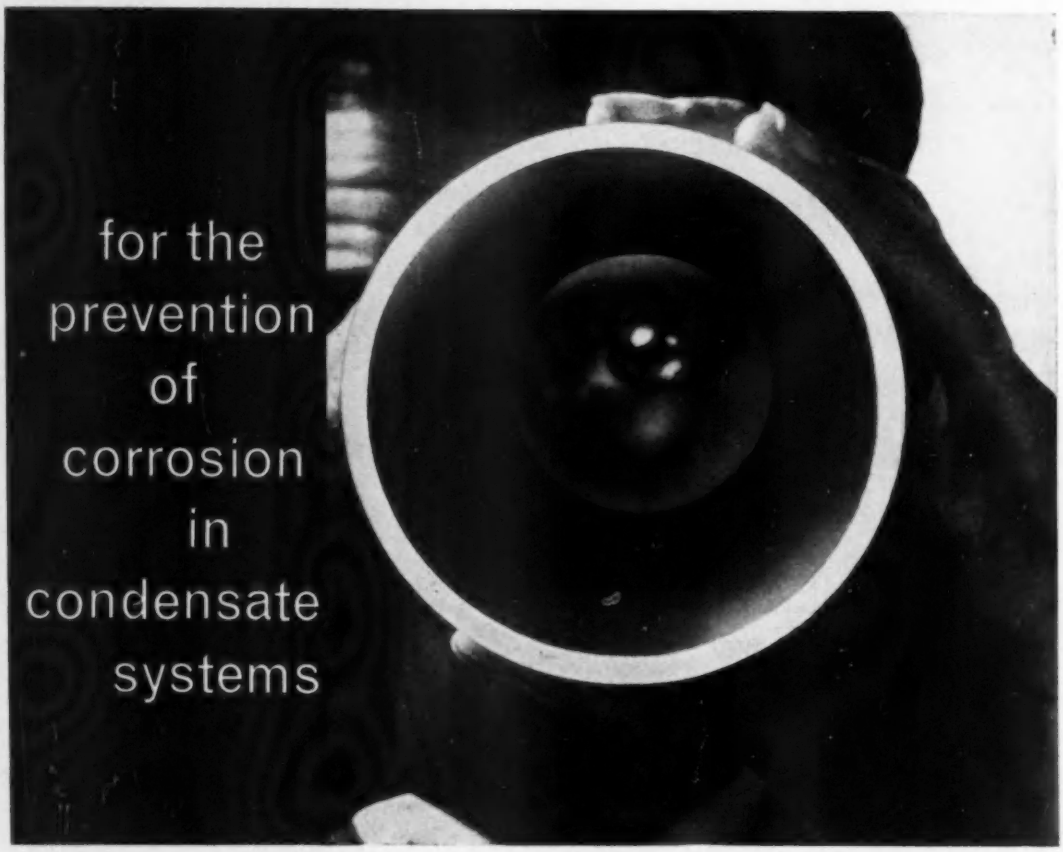
(never heard of 'em)

3 BUCKINGHAM PLACE · WESTMINSTER · S.W.1. Tel. VICtoria 4043/4

* *P.S.* We rather like old Theodore, hard to shift, but once convinced he certainly *stays* convinced.

NRP 2565

HAGAFILM



Corrosion kills efficiency. Hagafilm promotes efficiency—because it kills corrosion! In space heaters, process heaters, evaporators and condensate lines Hagafilm forms a non-wettable film that protects vital surfaces from corrosion and improves heat transfer to a remarkable degree. Hagafilm has for long been used in America with striking results. Now in the United Kingdom it is showing the same efficiency, and reducing maintenance and replacement costs considerably.
Wherever there is plant using steam, Albright & Wilson chemicals and technical service have a vital role to play. For example, phosphates are supplied for boiler water treatment. The phosphate conditioning of boiler water is now established as the best method of preventing scale deposits in all types of boilers.

For full details write to:

ALBRIGHT & WILSON (MFG) LTD

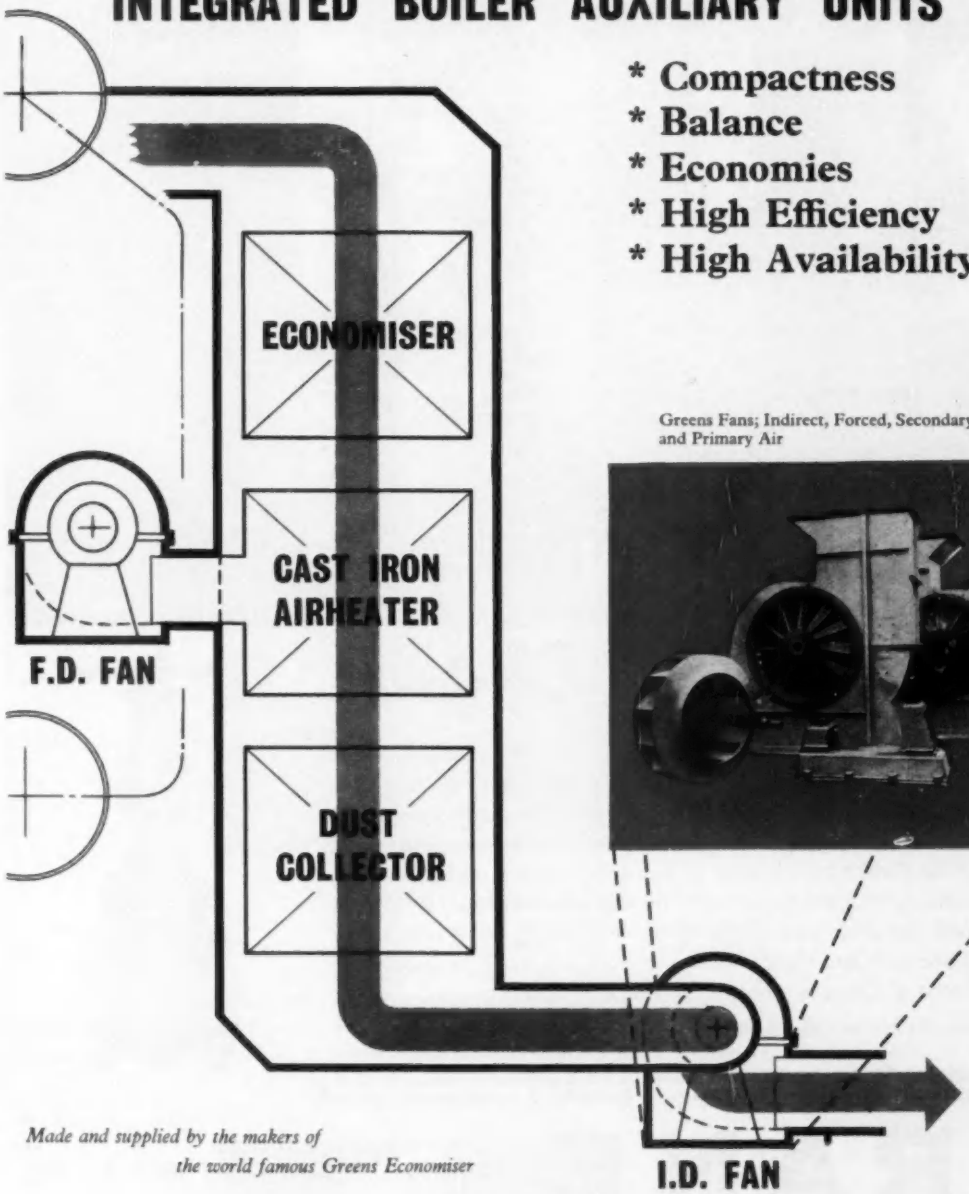
1 KNIGHTSBRIDGE GREEN · LONDON SW1 TEL: KENSINGTON 3422

From Boiler Back to Chimney Stack

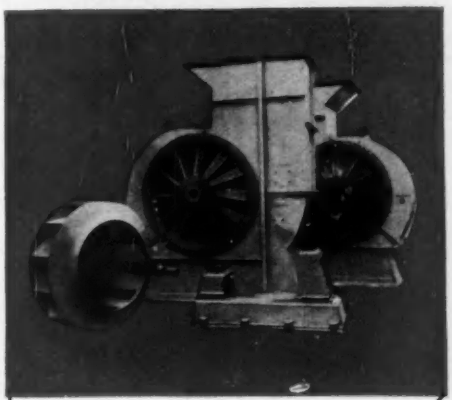
GREENS

INTEGRATED BOILER AUXILIARY UNITS

* Compactness
* Balance
* Economies
* High Efficiency
* High Availability



Greens Fans; Indirect, Forced, Secondary Air and Primary Air



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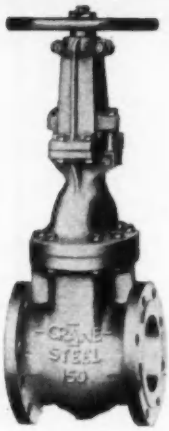
GE 209 B

ONCE AGAIN
VALVES BY CRANE

The new plant of The International Synthetic Rubber Company Ltd. at Hythe on Southampton Water is now in production in a big way. Once again Crane valves are playing an important part. The illustration above shows the recovery building, where the steam lines to the Styrene Strippers have been fitted with Crane 12 inch, 10 inch and 6 inch cast steel gate valves. In the administrative buildings too, Crane equipment is used, the central heating and domestic installations being very largely fitted with Crane Bronze Globe and Gate Valves. More and more industries are discovering that the name of Crane is synonymous with dependability.

INSTALLING ENGINEERS: Matthew Hall & Co. Ltd., London.



One of the valves used—the 47X in cast steel, with end connections to British as well as American Standards. Can be trimmed to suit a variety of services for high and low pressures and temperatures.

D30

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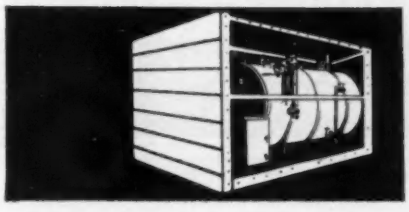

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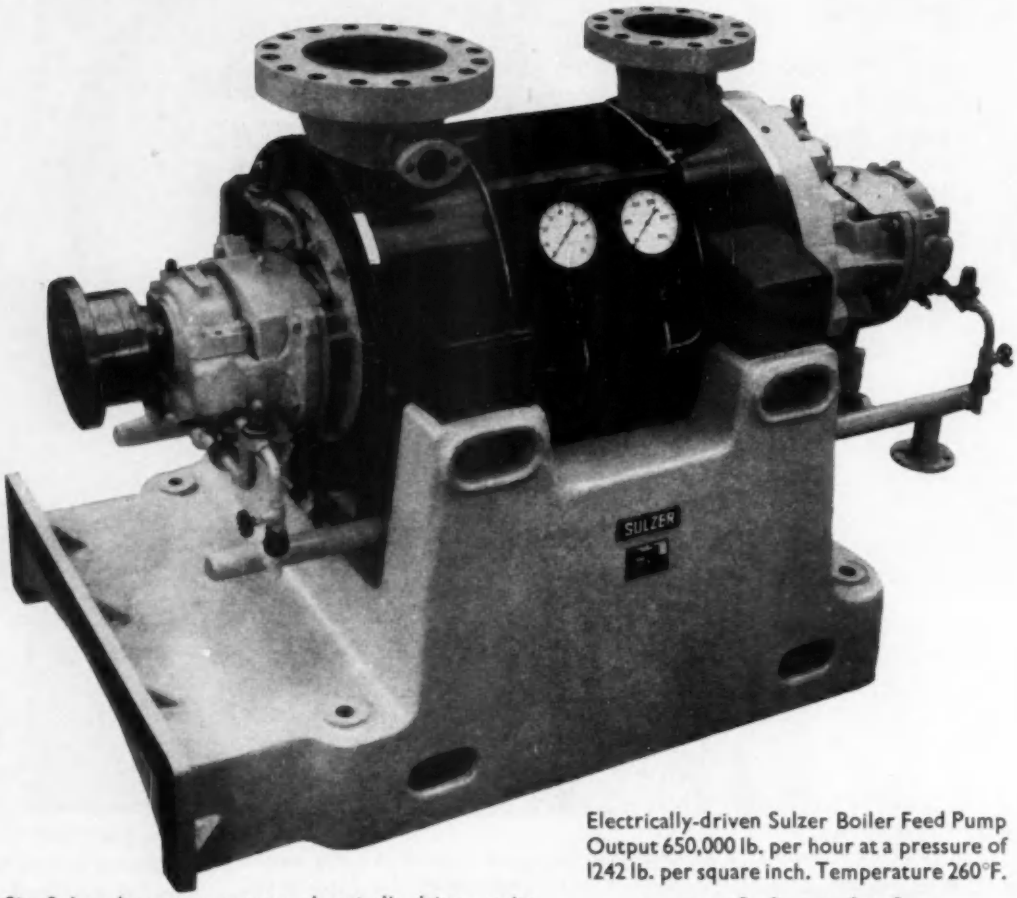

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Actually, it's no more amazing than all the other virtues of the remarkably versatile Spirax thermodynamic steam trap.

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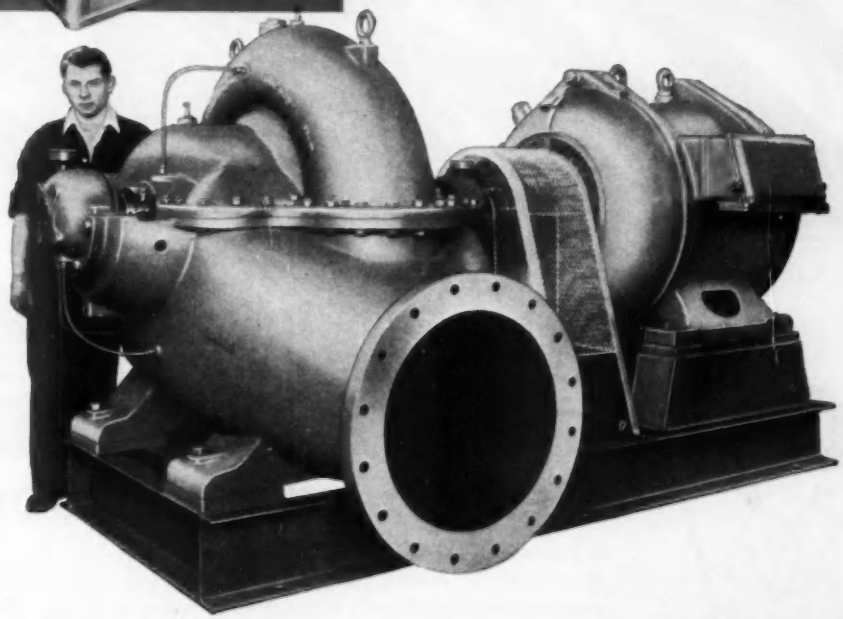
WS features mean better service

Type 'L' pumps of split case construction provide easy access to the interior without disturbing pipe or shaft connections. Above all, Worthington-Simpson reliability means long and efficient service with the minimum attention and maintenance costs. This versatile range covers capacities from 15 to 15,000 g.p.m.; heads up to 660 feet.



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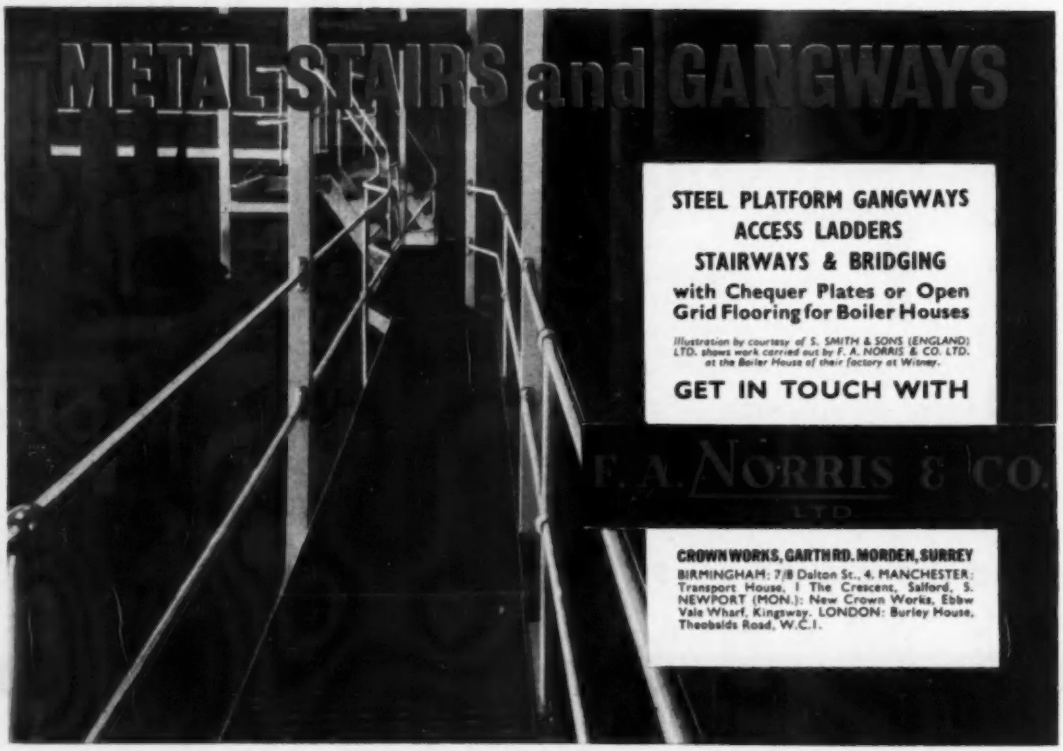
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STEEL PLATFORM GANGWAYS
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STAIRWAYS & BRIDGING
with Chequer Plates or Open Grid Flooring for Boiler Houses
Illustration by courtesy of S. SMITH & SONS (ENGLAND) LTD. shows work carried out by F. A. NORRIS & CO. LTD. at the Boiler House of their factory at Witney.
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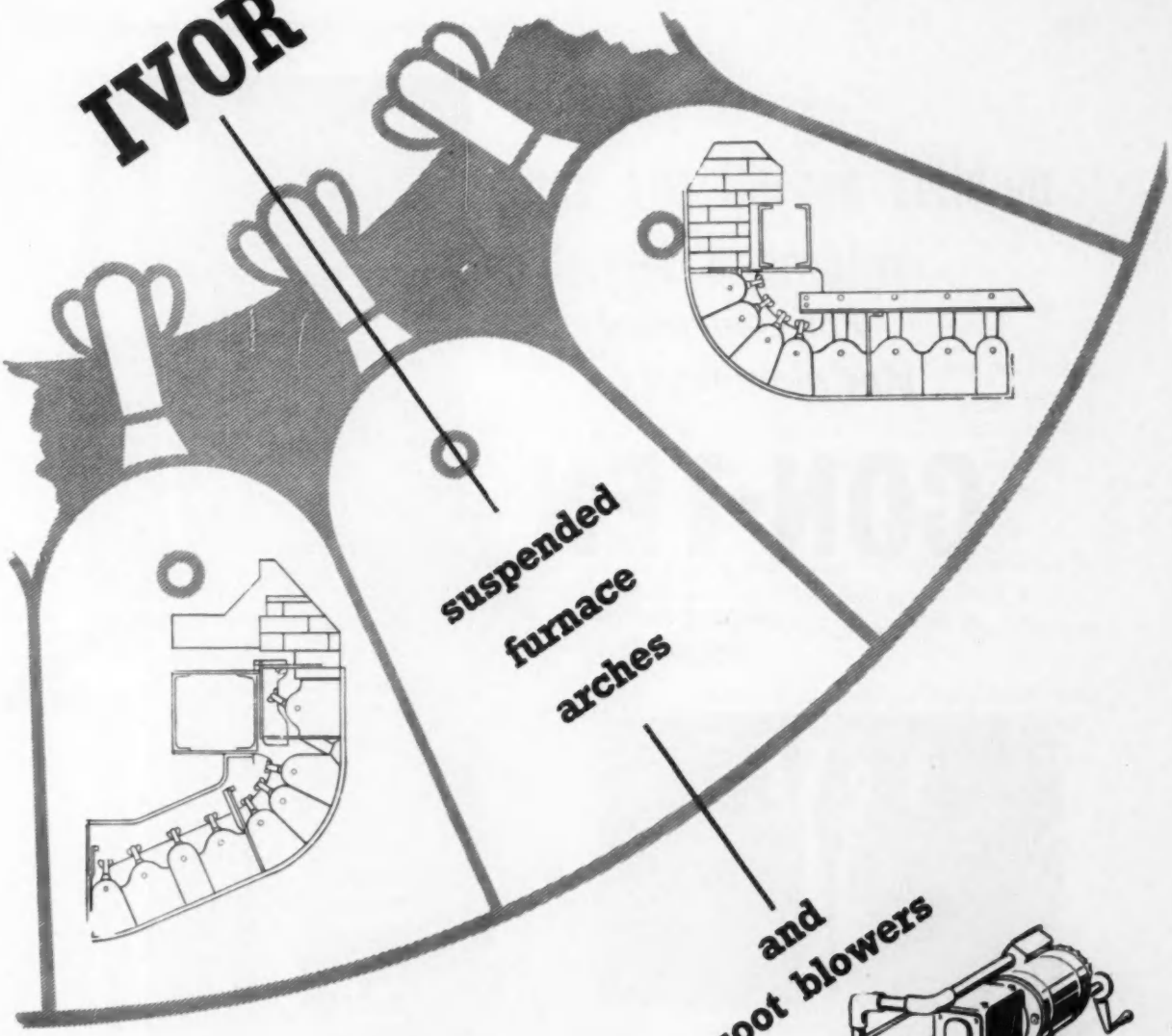

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Ivor Pendulum—suspended refractory arches
permit quick renewal of defective areas
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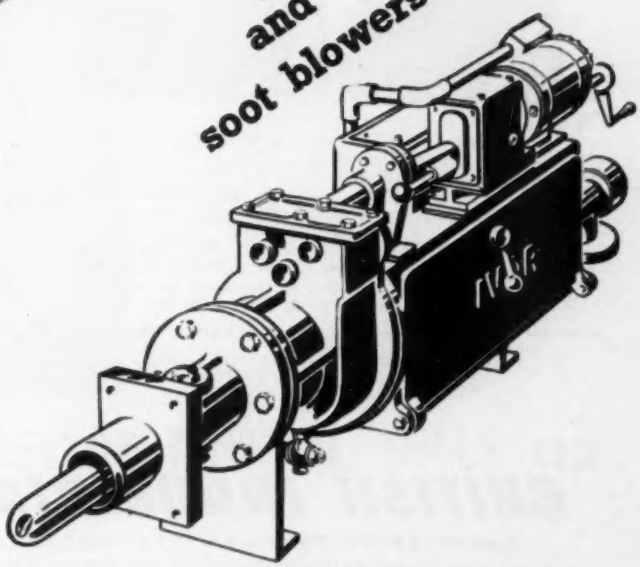

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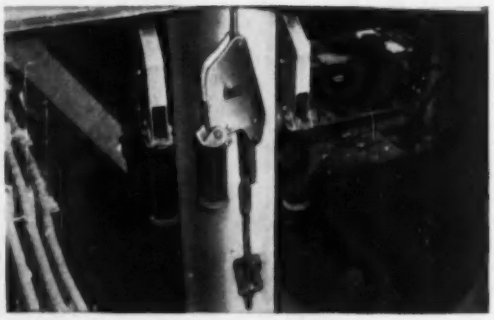
CONSTANT TENSION PIPE SUPPORTS



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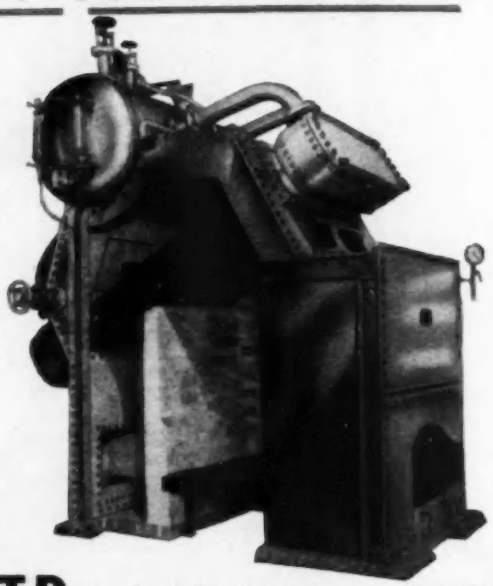

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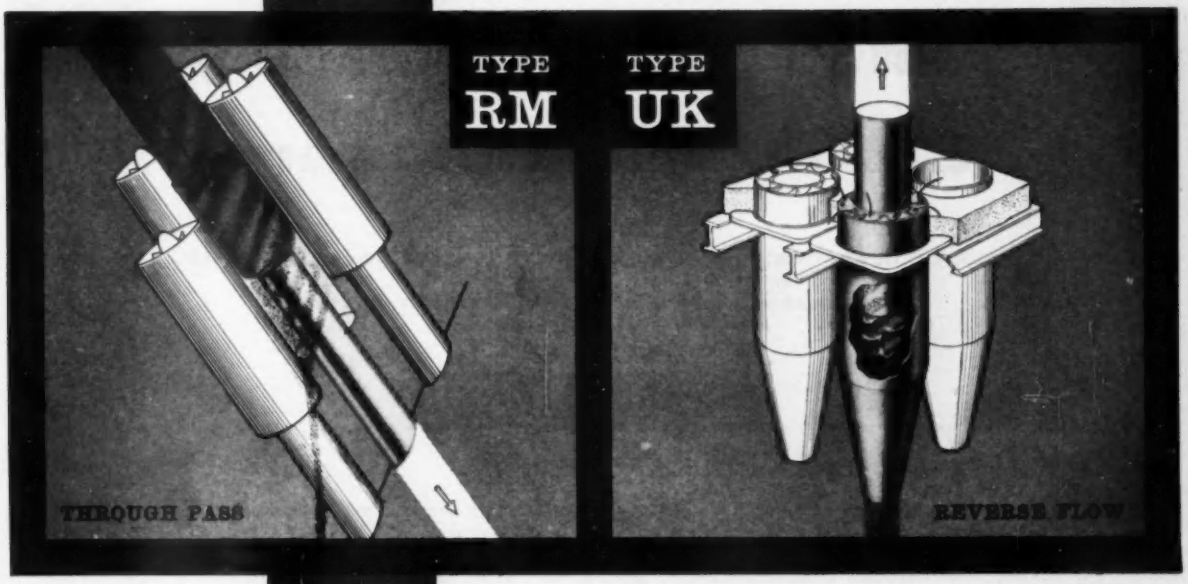

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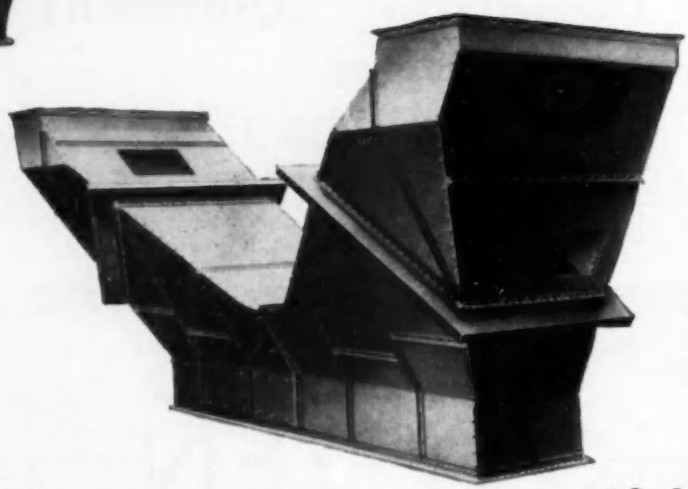

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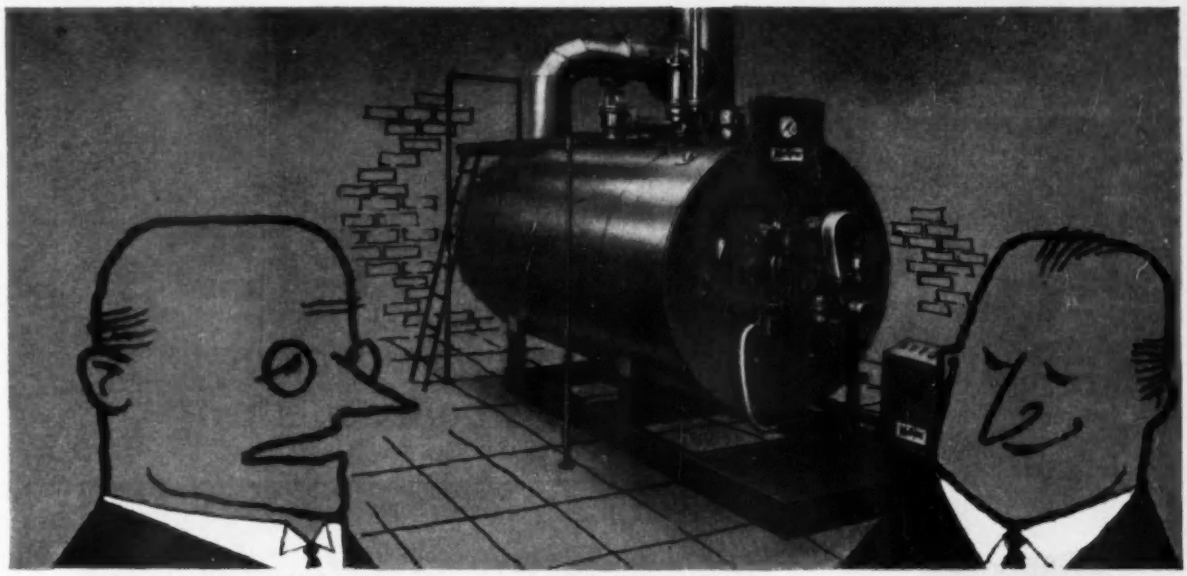

Smuts? that's the name of the cat!

We have a fastidious customer (we like him). He is in the food processing business where everything must be spotless. He's a hard man to impress. We showed him a *Multipac*, working. We demonstrated its efficiency on varying loads (eighty-two point something it was). We opened it up and let him see how little soot there was inside after six months' continual work. But he didn't enthuse.

We showed him what we meant by 'Clyde-built and tough,' and we showed him there was no refractory brickwork to replace because the *Multipac* has a new sort of *wet-back* combustion chamber. We let him stop it and start it, and finger its smooth clean finish. (We were beginning to lose our smile.)

Then he called his assistant and put 'smut-catchers' on our chimney.

Counting smuts is tricky, apparently. But he didn't have many to count. In three days he was truly amazed. *Multipac* is the least smut-making boiler he has ever met. Well, of course.

We will gladly send you descriptive literature. But better still, write or telephone to say you are coming to see a *Multipac* at work. We'll be delighted.

(This boiler can also be supplied for use with solid fuels.)

Multipac

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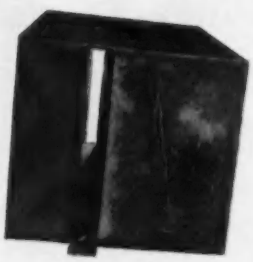
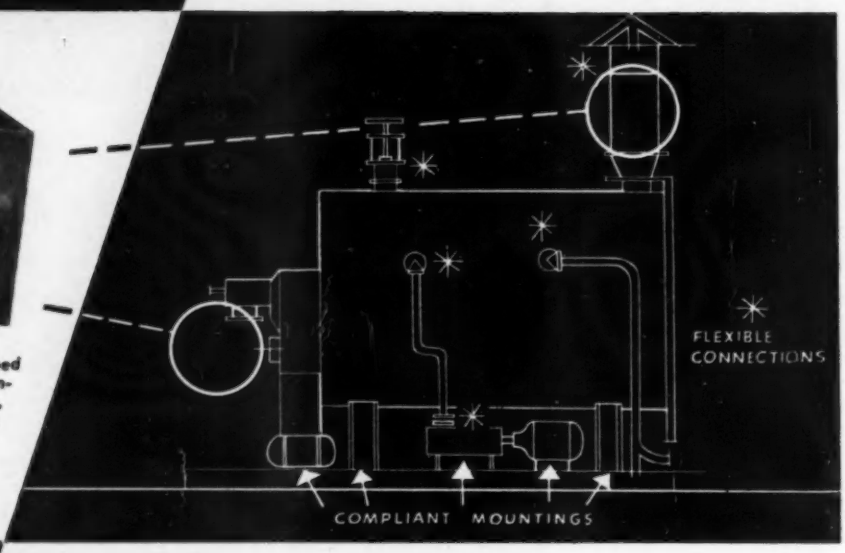
NOISY BOILERS

a new development in oil-fired boiler silencing



This newly developed "straight-through" silencer, of patented design, combines maximum attenuation with minimum resistance to a degree never achieved before.



Combustion noise from an Oil-fired Boiler, if allowed to pass up the flue, is not only likely to annoy the neighbours but can be transmitted most effectively around a building via the structure.

Furthermore, if permitted to escape through the air inlet into the Boiler Room itself, it will penetrate through every nearby door and window or other adjacent "weak spot," especially when amplified by reverberant conditions.

This new Silencer, which can be designed to give a reduction of 35 lb. down to 50 cycles if required, will now virtually eliminate combustion "rumble," normally predominant at the lower frequencies, at these two all-important sources.

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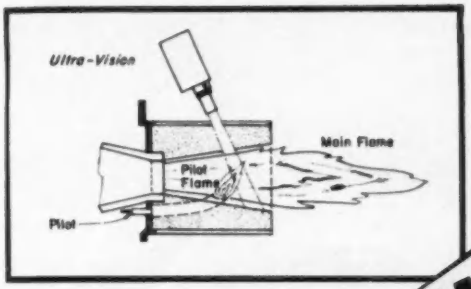

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sees flames only

Unique Honeywell Ultra-Vision eliminates flame simulation hazards— prevents unnecessary shutdown of oil or gas fired furnaces

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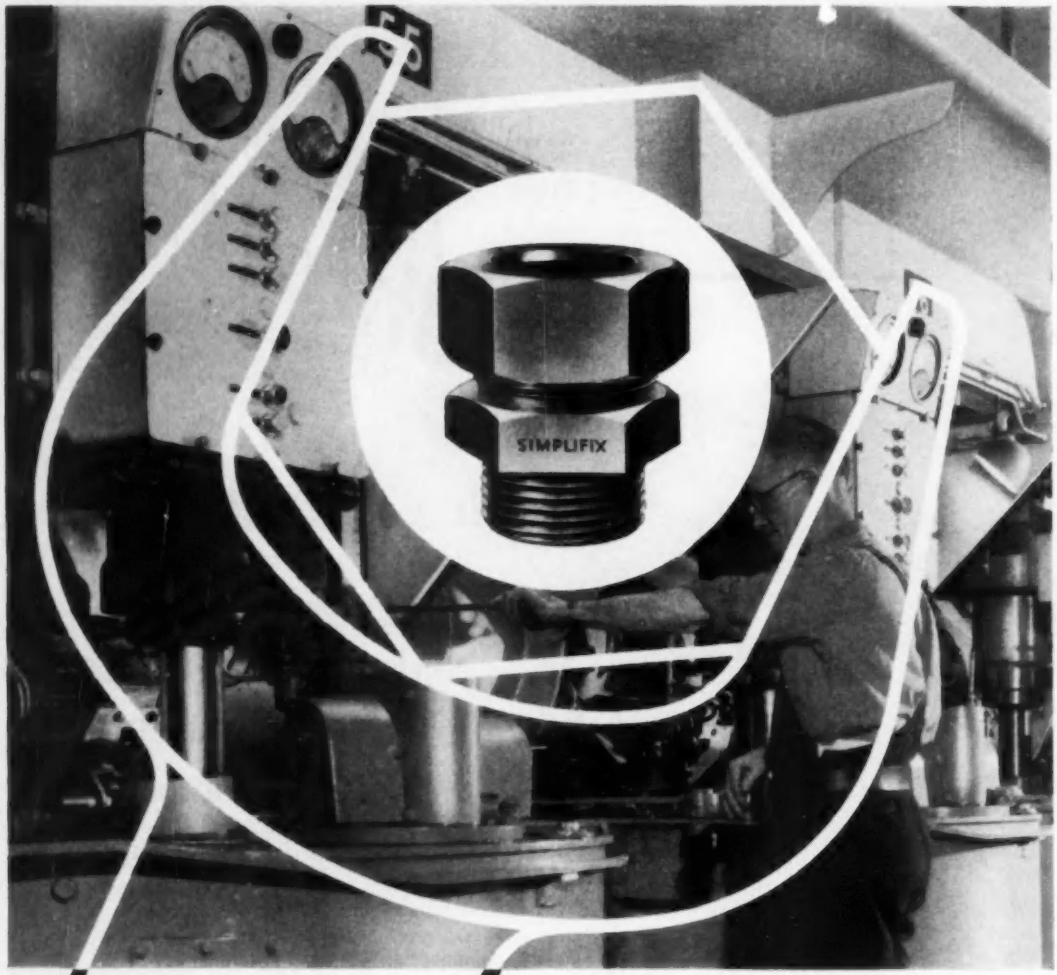

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Simplifix — the sure and simple compression coupling for copper pipe. Perfect joints with almost all kinds of tubing, including those with very thin walls. No work to do on the pipe. Simply tighten the nut — the anti-friction washer prevents pipe twisting. Manufactured since 1930, still the best. Millions in use. Made in sizes to suit tubing from $\frac{1}{8}$" to 2" O.D., in a wide range of interchangeable standard fittings. Non-standard fittings also made to order. Let us send you the Simplifix catalogue.

The illustration shows centrifugal machines at the Plaistow Wharf Sugar Refinery of Tate and Lyle Ltd., where large numbers of Simplifix couplings are used.

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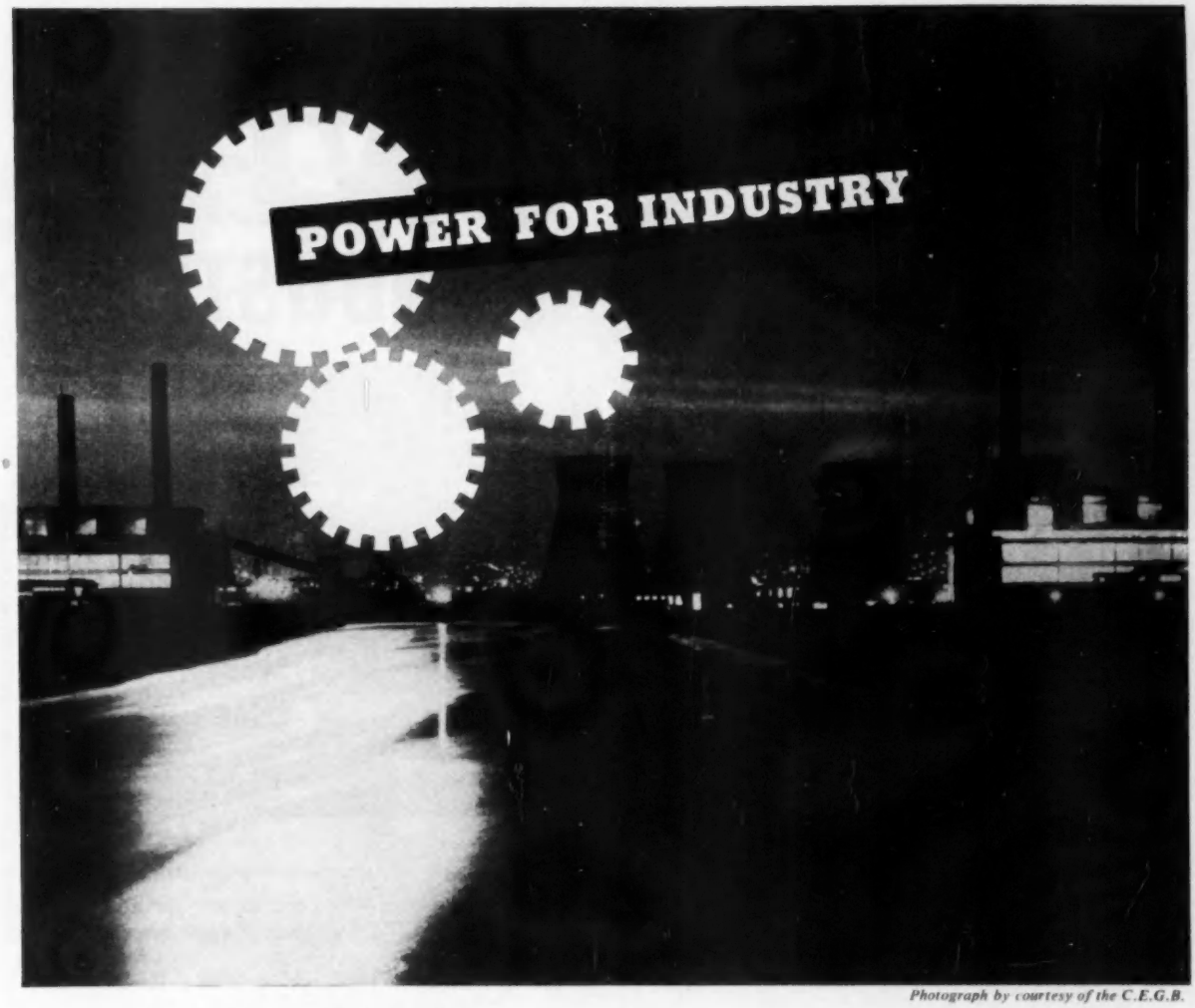

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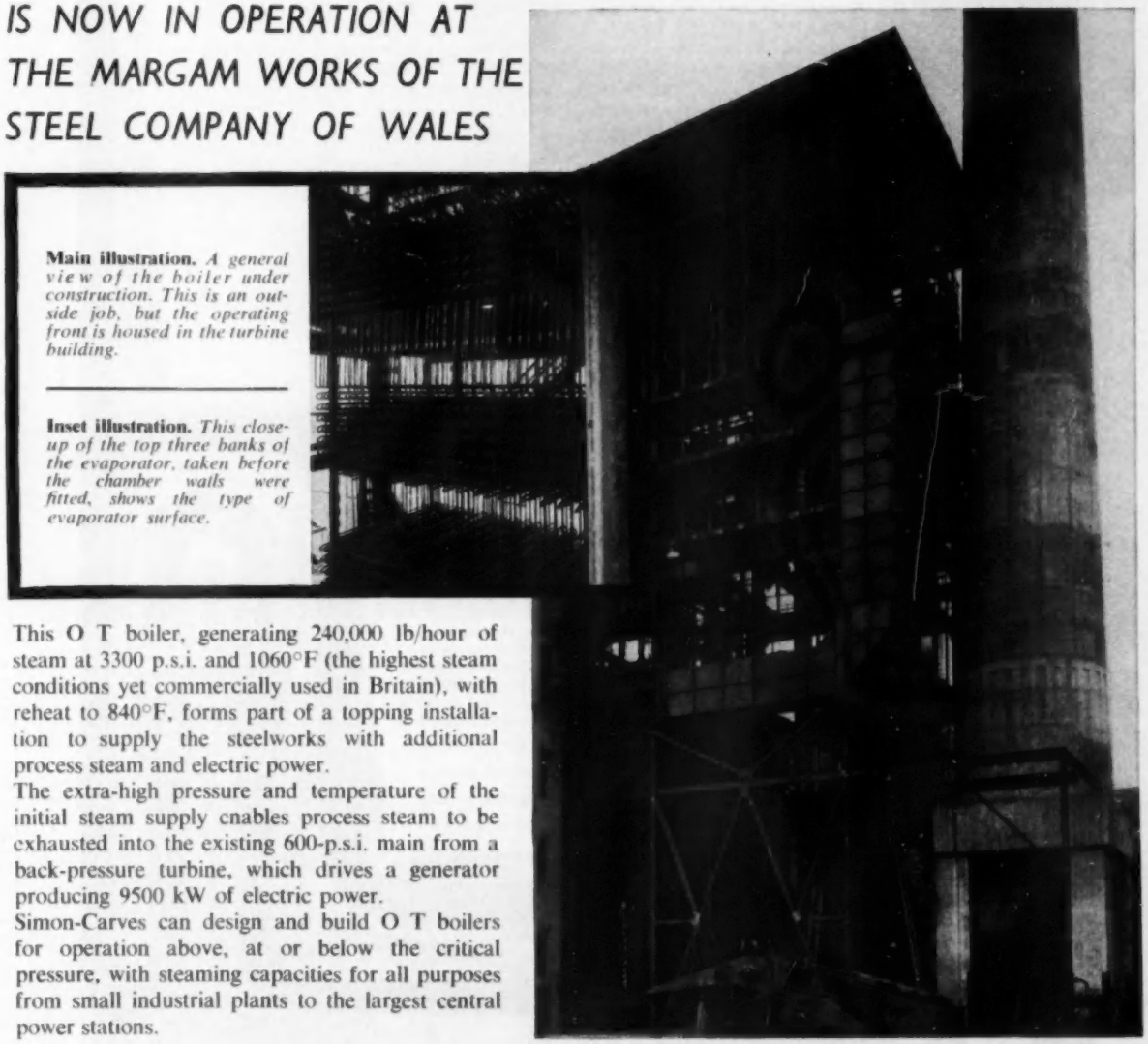

Main illustration. *A general view of the boiler under construction. This is an outside job, but the operating front is housed in the turbine building.*

Inset illustration. *This close-up of the top three banks of the evaporator, taken before the chamber walls were fitted, shows the type of evaporator surface.*

This O T boiler, generating 240,000 lb/hour of steam at 3300 p.s.i. and 1060°F (the highest steam conditions yet commercially used in Britain), with reheat to 840°F, forms part of a topping installation to supply the steelworks with additional process steam and electric power.

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Simon-Carves can design and build O T boilers for operation above, at or below the critical pressure, with steaming capacities for all purposes from small industrial plants to the largest central power stations.

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The first *complete* Power Station to operate at 1,500 p.s.i. and 1050°F. was opened at Drakelow in October 1955. Right from the beginning, Zerox (35% hydrazine) was chosen for the treatment of the boiler feed water. By the end of the first year, Drakelow had proved itself to be the most efficient Power Station of its kind in Great Britain. Since then it has completed a further two years of exemplary service for the East Midlands Division of the Central Electricity Generating Board, maintaining, for this type and design of Station, an unsurpassed standard of performance.

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The results—less blow-down, purer water, cleaner internal surfaces—explain why Drakelow and numerous other Power Stations use Zerox

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to ensure maximum efficiency

For more FACTS about ZEROX, its advantages and application, write to WHIFFENS, sole manufacturers, for Leaflet H/H/2—or for the fully bound book of the International Conference on Hydrazine and Water Treatment held in May 1957. Price one guinea, plus 2s. 6d. postage and packing (in the U.K.)

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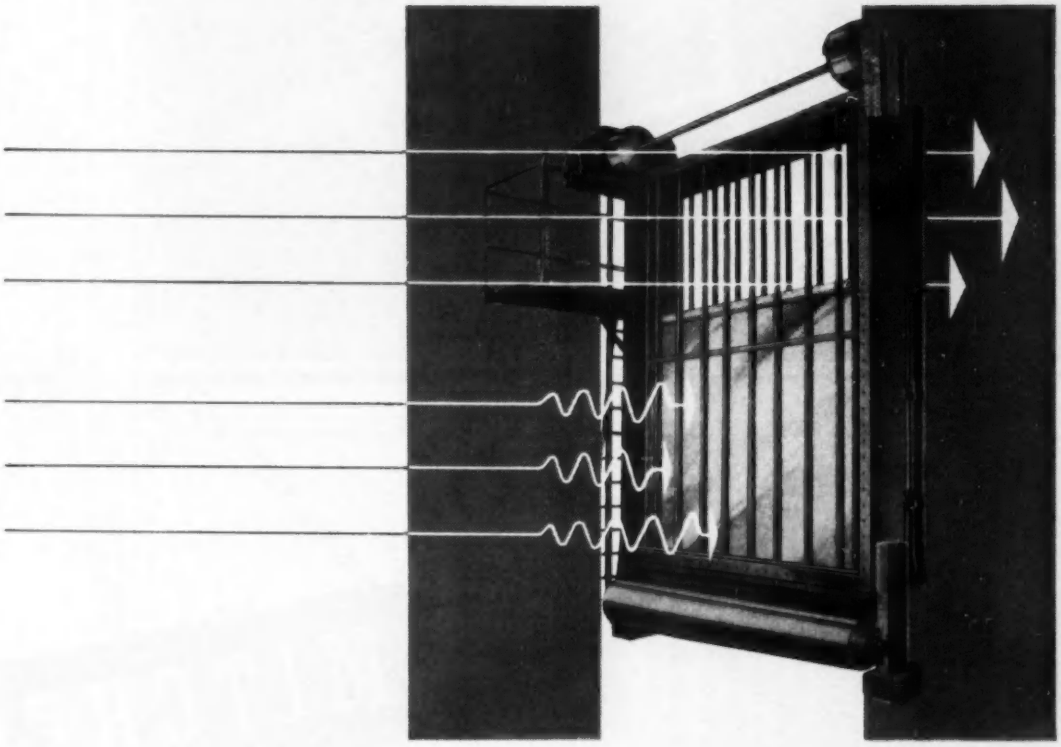
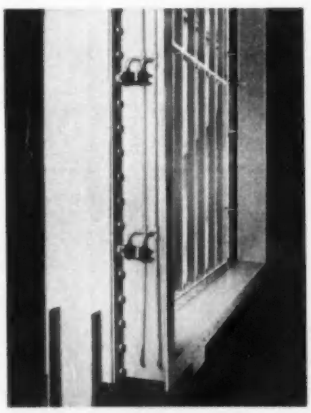


The Dowling Damper



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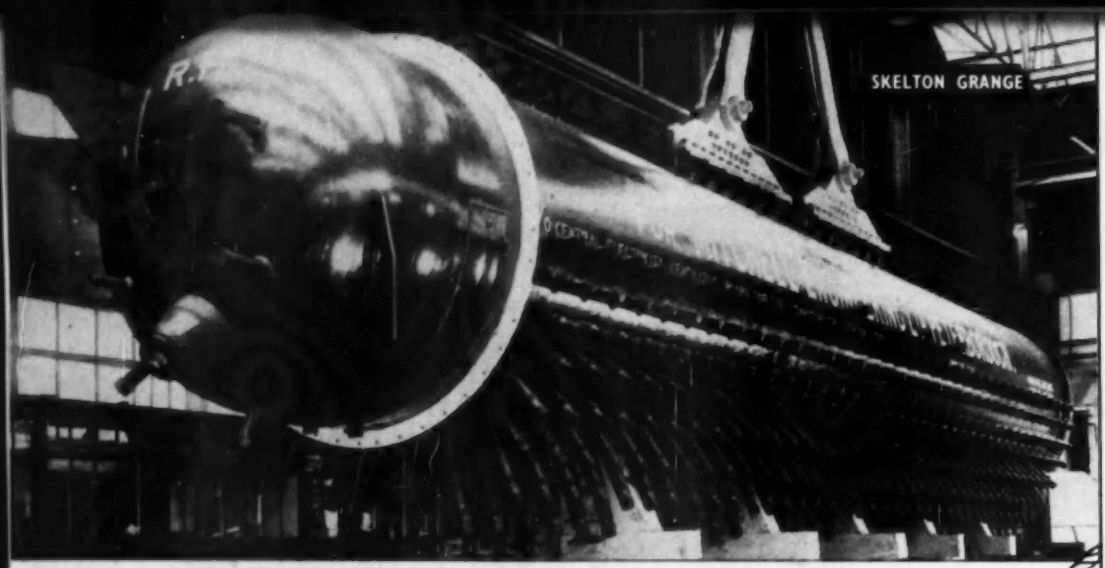

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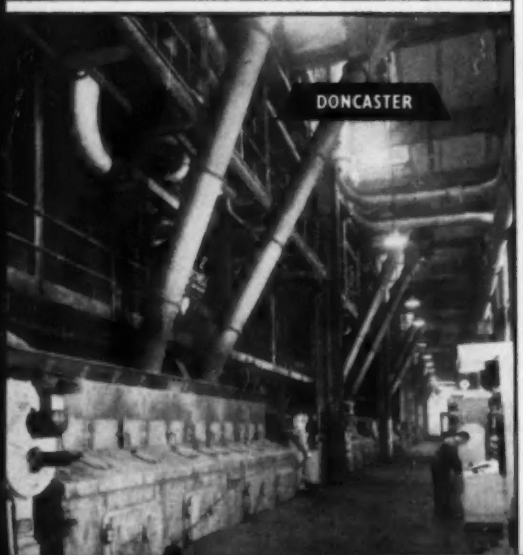

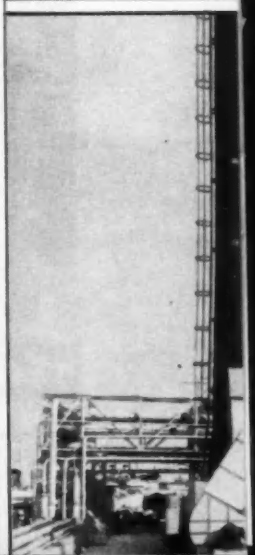

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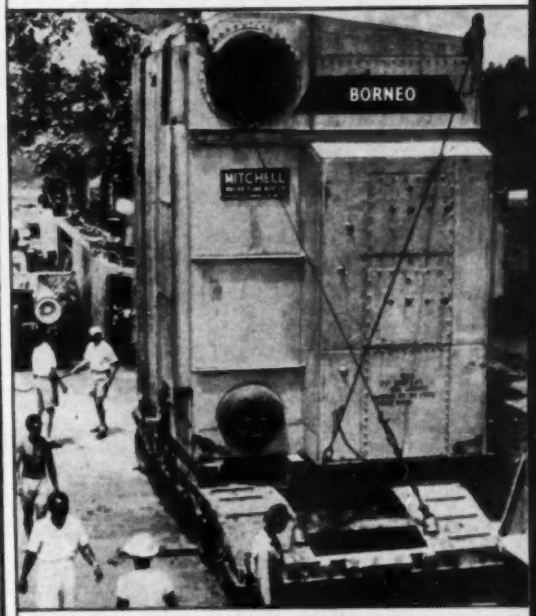

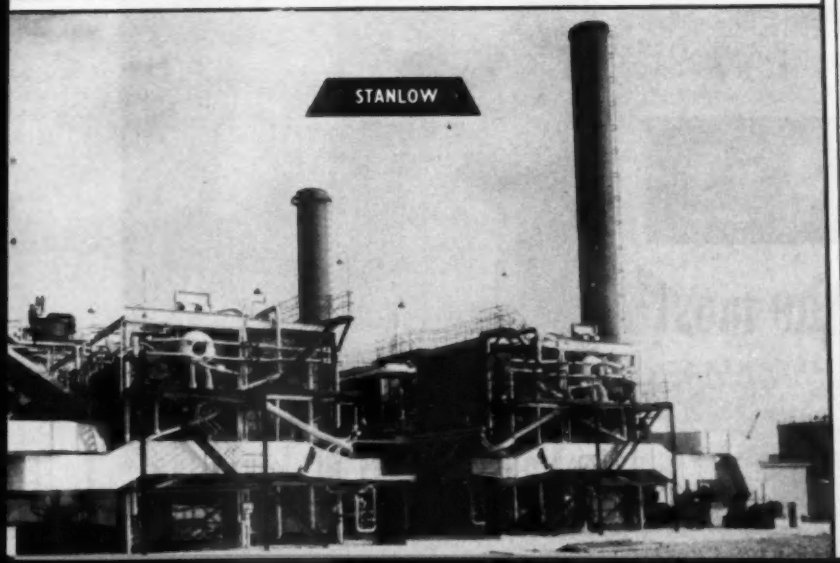

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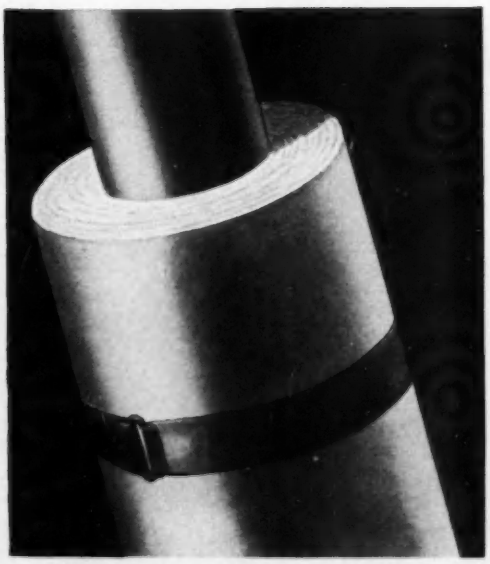

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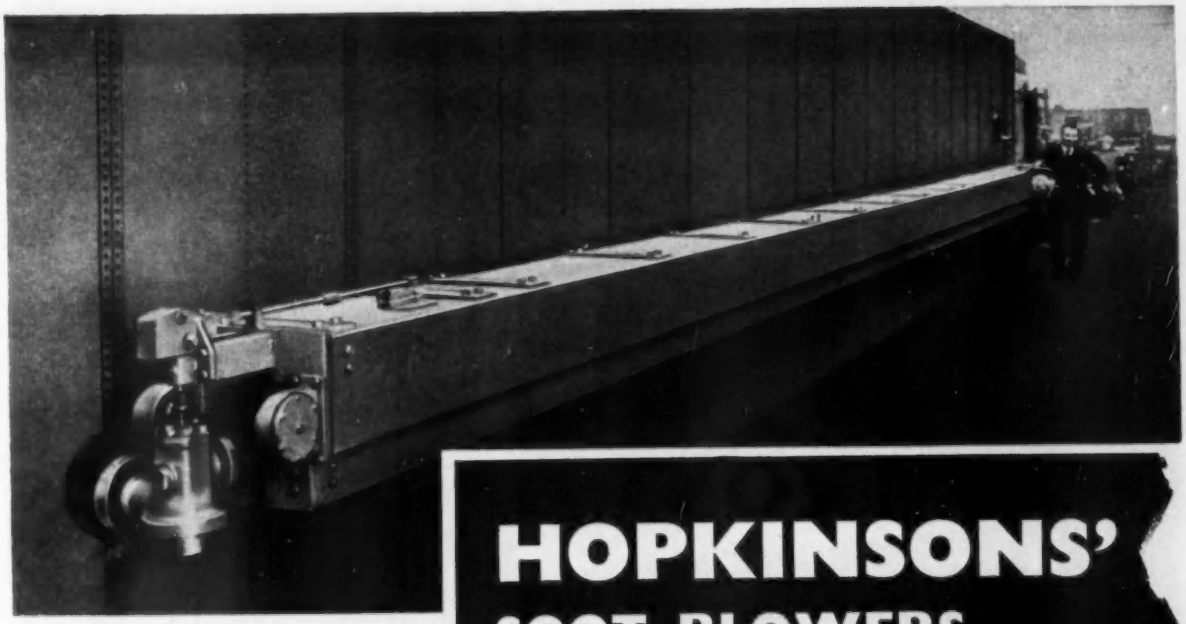

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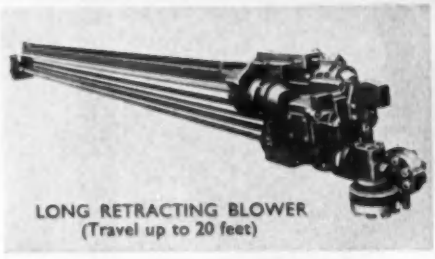
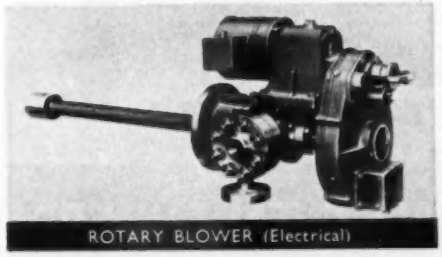
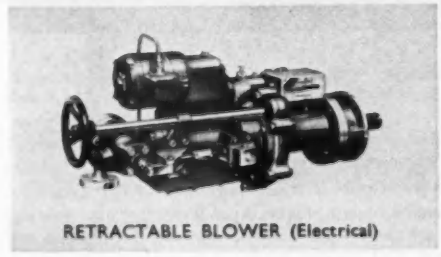


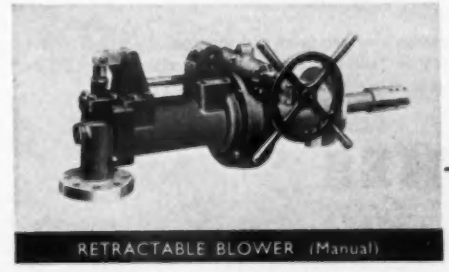
LONG RETRACTING BLOWER
(Travel up to 20 feet)



ROTARY BLOWER (Electrical)



RETRACTABLE BLOWER (Electrical)



RETRACTABLE BLOWER (Manual)

The above photograph shows one of Hopkinsons' long retracting soot blowers, with a travel of 36 feet. Blowers of this design are on order for the largest single-furnace boiler in the world, at Thorpe Marsh Power Station near Doncaster.

Hopkinsons' soot blowers are standardised to suit all types of boiler installations; our illustrations depict several well-known types.

Hopkinsons' soot blowers are in use in—

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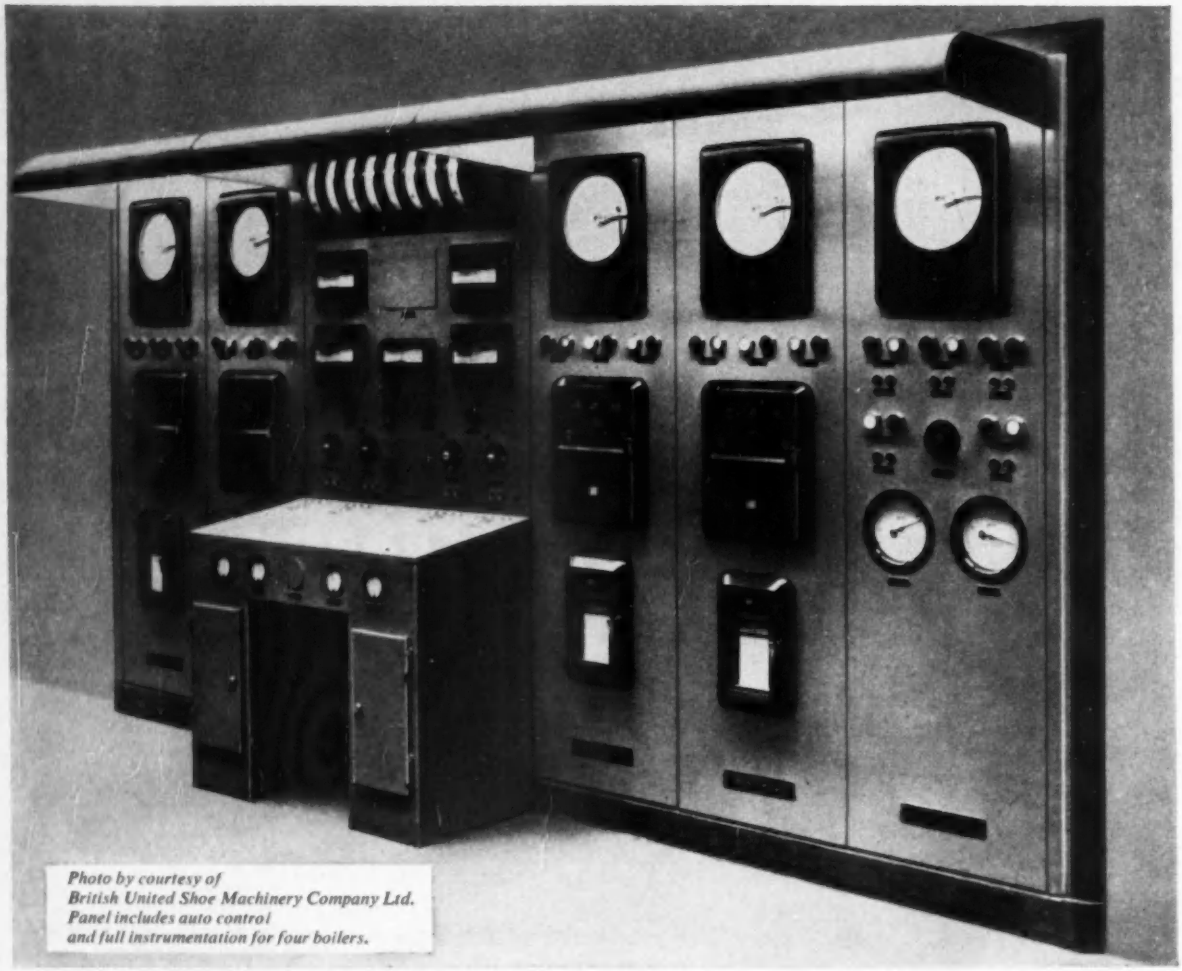

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Many unique features. Kelvin Hughes Auto Boiler Control includes a balanced draught control and interlock system which positively prevents blowback, and a system for d.c. type stoker motors which ensures accurate fuel feed.

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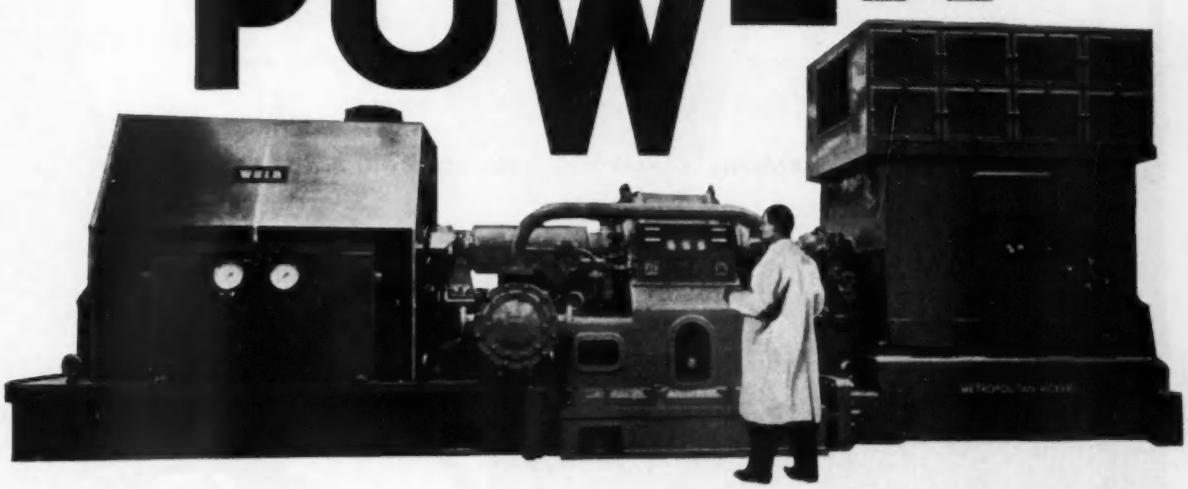

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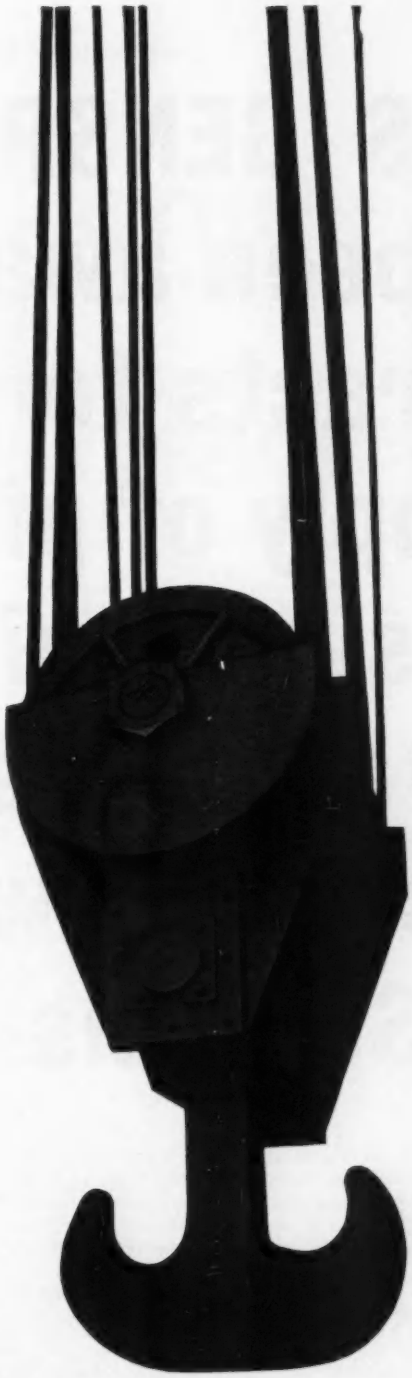

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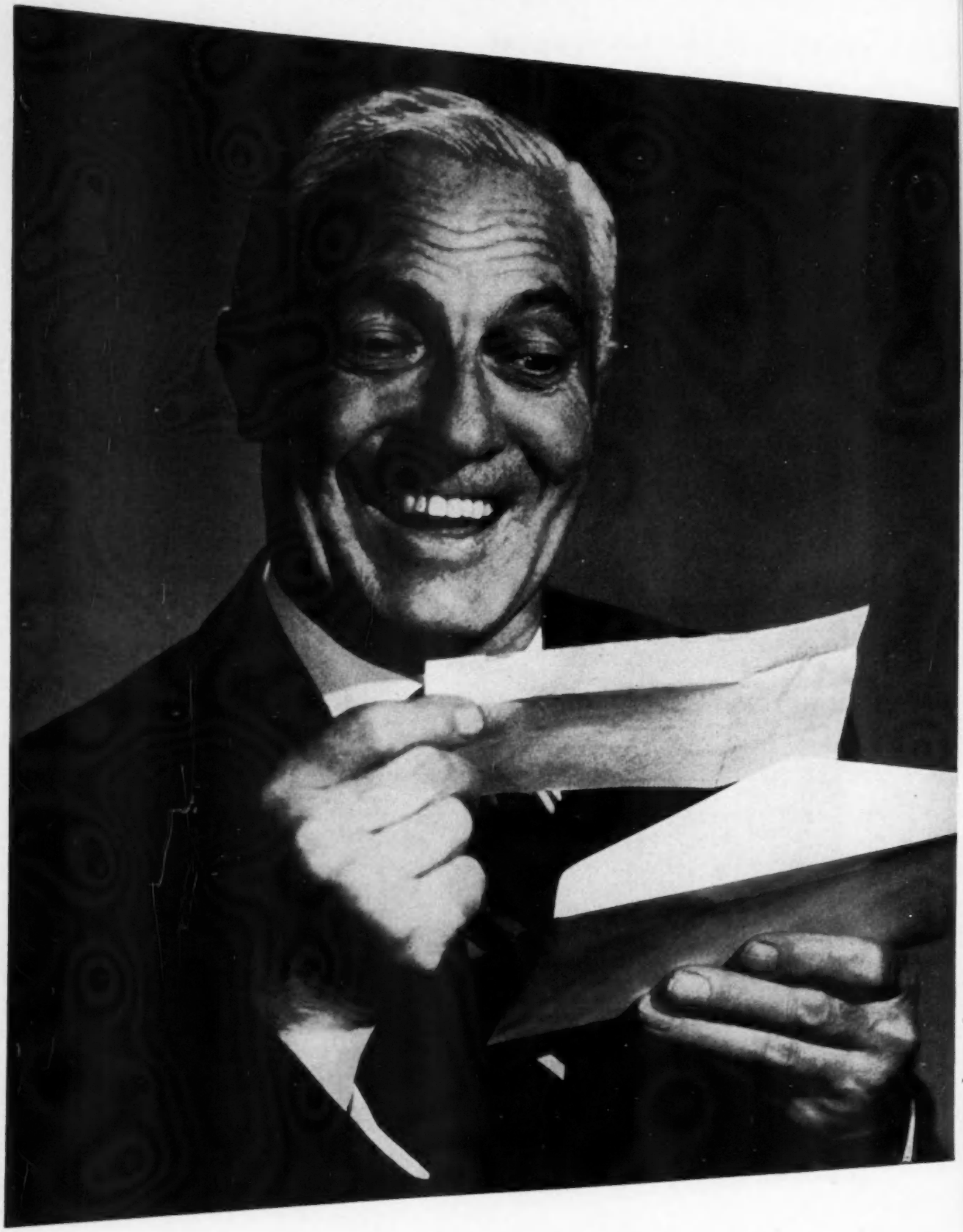

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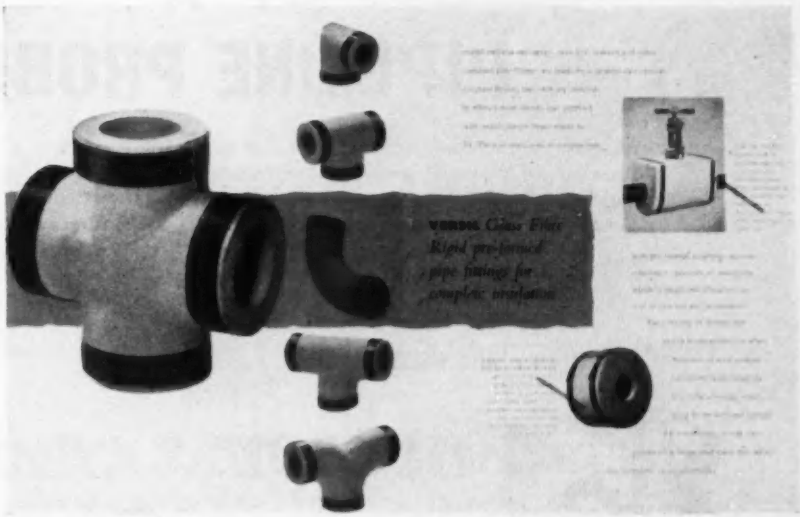

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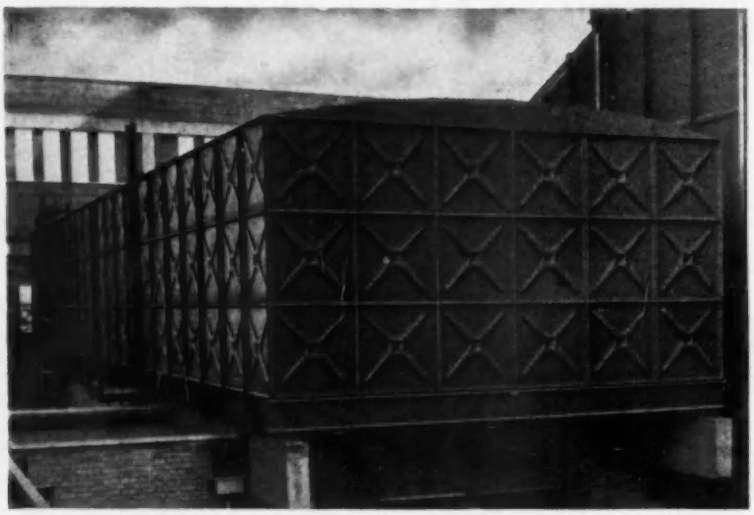

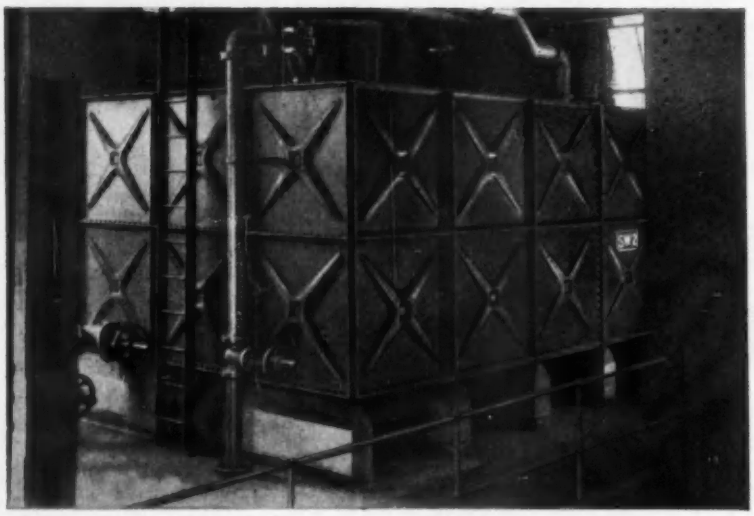

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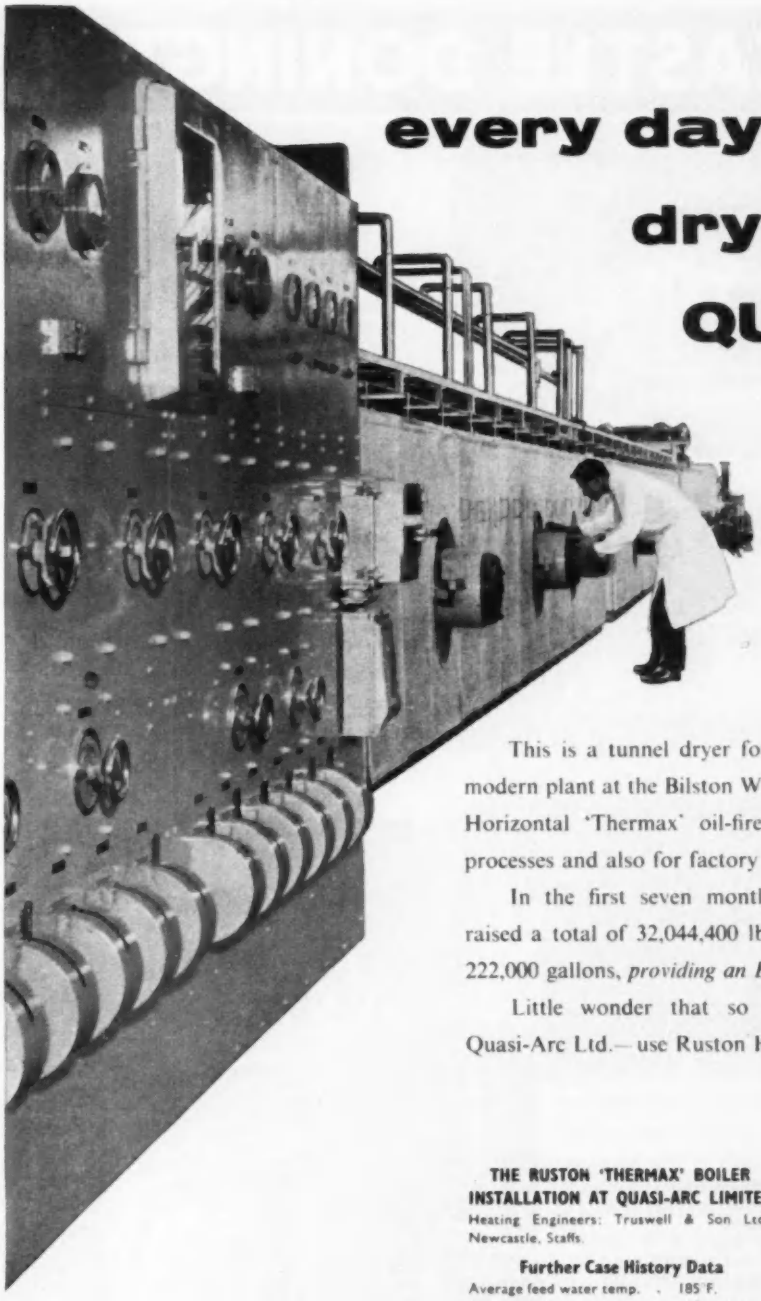

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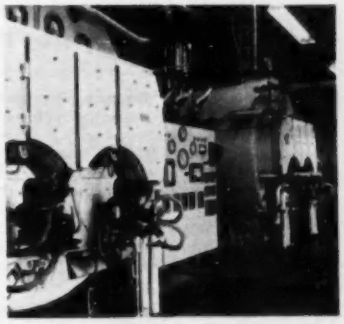
Further Case History Data

Average feed water temp.	185°F.
Average boiler pressure	110 p.s.i./gauge
Average CO_2 reading	13%
Average exit flue gas temp.	420°F.



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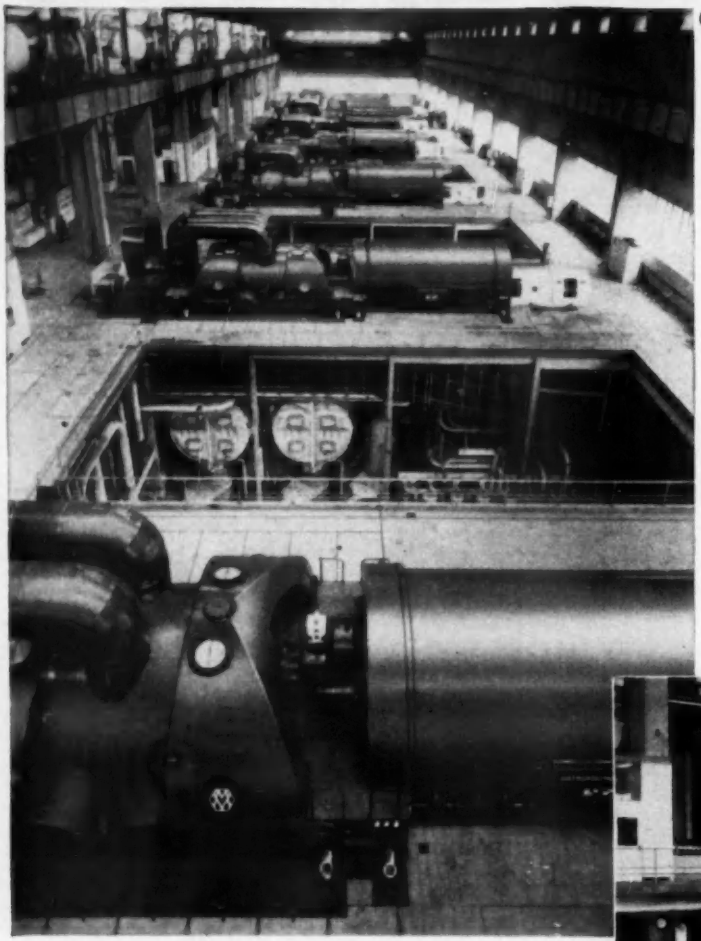

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C.E.G.B. East Midlands Division.

The largest single thermal power station in Western Europe

Castle Donington houses six 100 MW 3000 rpm steam turbine-generators together with their associated condensing plants and feedwater heating equipments. All this power plant was manufactured by A.E.I. Turbine-Generator Division.

Castle Donington recorded the highest average overall thermal efficiency of any British power station during the three years ending 31st March 1959.

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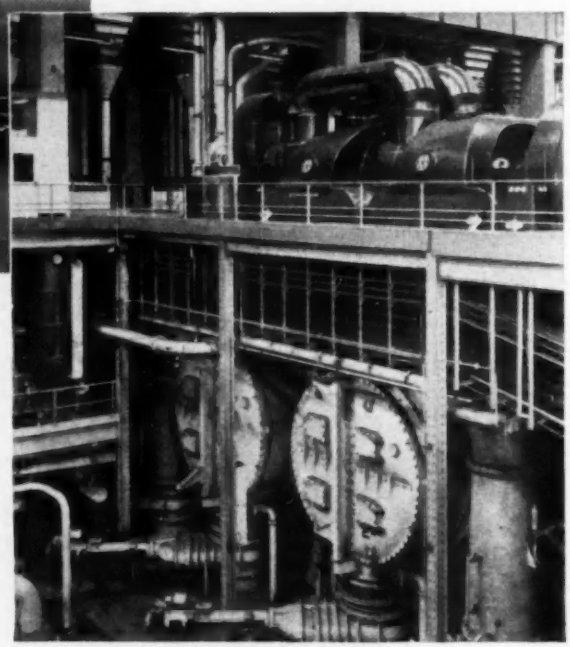
Direct-coupled generators produce 3 phase, 50 c/s alternating current at 13·8 kV. The rotor windings are directly cooled by hydrogen circulating in contact with the copper.
The generators are directly connected to the A.E.I. main step up transformers and the power is controlled to the grid by A.E.I. circuit-breakers.



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Engineering and BOILER HOUSE REVIEW

THE OLDEST ESTABLISHED STEAM ENGINEERING PUBLICATION

FEBRUARY 1960

VOLUME 75. No. 2

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The Editor will be glad to receive and consider original contributions, correspondence, etc., of a suitable nature for publication. Stamped and addressed envelopes should be enclosed for the return of any matter considered unsuitable

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Central station boiler development in recent years has been remarkable for the steep rise in unit capacities, with parallel advances in steam conditions and the extensive use of reheat; achieving valuable gains in thermal efficiency. This development reflects intensive progress — in design, engineering and manufacture — by the BABCOCK organization, which has supplied, or is currently manufacturing, a considerable number of boilers of from 100 to 300 MW capacity, and which is now to supply a unit of 550 MW capacity — the largest in the world and the first to provide this huge output from a single-furnace design.

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Engineering and BOILER HOUSE REVIEW

FEBRUARY 1960

VOLUME 75 No. 2

COAL PROSPECTS

AT a meeting which we attended in London on January 13th, Sir James Bowman, chairman of the National Coal Board, made his annual comments on the coal industry's activities during 1959, and assessed the prospects for 1960. Sir James said that although the Board's accounts for the past year were not yet available, it was known that a deficit was incurred. Nevertheless, the Board would endeavour to ensure that coal prices would remain stable, as they had done for the past two and a half years, provided a further increase in efficiency such as that achieved during the last two years can be obtained, and that external influences do not affect the Board's finances. Though productivity in the coal industry rose last year by a record amount, the main effect was simply to add to the Coal Board's already embarrassing stocks. The world-wide coal surplus continued in 1959, and the total consumption of British coal, which had fallen by 20 million tons between 1956 and 1958, decreased by another 13 million tons. The Board reduced deep-mined coal production by six million tons, mainly by closing 58 collieries (making a total of 90 in two years), and by further reducing the labour force (almost entirely by allowing normal wastage to outrun recruitment), which since the end of 1957 has decreased by 70,000 to a total of 640,000 at the end of 1959. Furthermore, opencast production was reduced by 3½-million tons.

Briefly, figures show that this country's coal output in 1959 amounted to 206 million tons (9 million tons less than in 1958), home consumption 190.5 million tons (12-million tons less than in 1958) and export and overseas bunker requirements were 4.3 million tons. Thus, this state of affairs inevitably meant further additions to the undistributed coal stocks which, by the end of the year, had reached a total of 36 million tons. By putting coal to stock, the Board had been able to meet the first shock of the fall in demand, but it had been expensive. In fact, in Sir James' own words, the Board's deficit was "Wholly accounted for by costs and provisions incurred through stocking." The Board now hopes that in 1960 there will be no further increase in stocks. There is some evidence to justify this expectation, as, since the beginning of this winter, stocks have been reduced by 1¾ million tons; during the similar part of last winter the fall was only ¼-million tons. It may be that supply has now been more or less equalised with demand—as demand now is. But the real difficulty is, that over the past few years, coal has been losing heavily to oil while at the same time suffering from the effects of increased fuel efficiency.

Referring to the problem of the piling up of stocks, Sir James Bowman said nothing was more stupid than the suggestion that there should be bargain sales of these stocks. Bargain sales would not be justified, since the great bulk of the demand for coal was relatively unresponsive to short-term price changes. Increased sales from stock would generally bring corresponding reductions in sales from current production, and result in further stocking and financial losses. Dealing with the prospects for 1960, Sir James said: "After consultation with the Government and main consumers, the Board estimate that home consumption will reach 196 million tons, which is about 6 million tons more than in 1959. Coke-oven plants and power station boilers expect to use more coal. Industrial production is rising again and, despite fierce competition from oil, coal requirements in the coming months may reasonably be expected to be higher than in the last two years or so. Nevertheless, it is evident that output will have to be reduced below the 1959 level. To encourage the use of mechanical stokers and other types of efficient coal-burning plant which satisfy the desire for clean air and the users' demands for economy, the Board are working closely with the British Coal Utilisation Research Association, with appliance manufacturers, and with professional institutions and others.

Coal preparation facilities are also being used increasingly to help those industrial consumers who find difficulty in using coal with a high content of "fines." More than three million tons of fines are now being extracted in the dry state before the washery process, in order to supply these consumers with a more convenient product.

Perhaps the most heartening part of Sir James Bowman's statement was that dealing with the industry's improving efficiency. In 1959 output per manshift was 6 per cent. higher at the coal face and 5.3 per cent. higher overall than in the preceding year, and was, in fact, the biggest increase recorded for over thirty years.

Points and Pointers

APPRENTICE STANDARDS IN ELECTRICITY SUPPLY

A word of warning on the position of student engineering apprentices in the electricity supply industry has been given by the Electrical Power Engineers' Association. Over the past five years, says the Association, there has been a fall in the number of graduate trainees from 143 to 42, and only five of them are holders of degrees. This surprising fall, in an industry so well endowed with corporate engineers, was going on while the number of student apprentices was rising, over the last four years, from 1,500 to 2,124. Closely linked with the employment policies of the electricity supply industry is the question of the career opportunities before the ambitious engineering student. The Electrical Power Engineers' Association regrets the action of the Institution of Electrical Engineers in tightening up their rules and requirements in such a way that the path to corporate membership for higher national certificate holders, while not blocked, may be described as very narrow. The Association has made it known that it would like the Electricity Council to ask the Institution to re-examine its requirements and perhaps make them rather less stringent, at least while the present shortage of professional engineers lasts. It is fair to observe here, that this business about a shortage of professional engineers, while being hallowed by long and frequent repetition, is also a matter of discussion rather than undisputed fact. What, perhaps, the association should be asking the Electricity Council to urge is that the reversal of this drop in graduate trainees in electricity supply be brought about in the interests of a more efficient supply industry.

ELLIOTTS EXTEND VALVE INTERESTS

It was announced recently that the Elliott-Automation Group has widened the scope of its interests in the manufacture of control valves, by the purchase of Black Automatic Controls Limited, of Corsham, Wilts., manufacturers of a wide range of control valve and pressure-regulating equipment. Elliott-Automation, through its Valve Group of companies at Rochester, is one of the most important manufacturers of control valves in Europe. Elliott-Automation, which owns twenty-five companies, all operating in the field of automation, has now, including Black Automatic Controls, four companies producing control valves of various kinds. The largest of them is The Fisher Governor Company, with a turnover running into seven figures. It has recently commenced its own operations in Australia. The other valve companies in the Group are—Farris Engineering Limited, which specialises in safety relief and flexible valves, which are used with corrosive and abrasive materials, and James Gordon Valves Limited, which designs and manufactures valves of all types for specialised applications. With the acquisition of Black Automatic Controls, the group's valve interests in the gas and chemical industries are again being expanded. The acquisition of the company is thus, a further example of the policy of the E.A. Group, as announced by Mr. Leon Bagrit, deputy chairman and managing director, of continuously expanding its interests in the field of automation.

NEW YEAR HONOURS

While the electricity supply industry is nothing like so well represented in the New Year Honours as in recent years, many well-known men in the electrical and allied industries are included in the list. The outstanding feature of the list from the point of view of the electrical industry, is the peerage conferred upon Sir George Nelson, Bt., who, as chairman of the English Electric Co. Ltd., has done a great deal for the industry and for the country's export business. Two other men well known in the industry are among those upon whom knighthoods are conferred, viz.—Mr. J. F. Lockwood, chairman of E.M.I. Limited, and Mr. A. B. Waring, chairman and managing director of Joseph Lucas (Industries) Limited. Among new Commanders of the Order of the British Empire (C.B.E.), are Mr. D. D. Cruickshank, E.D., B.Sc., M.Inst.C.E., M.I.Mech.E., general manager, Renfrew and Dumbarton Works, Babcock & Wilcox Limited; Mr. L. J. Davies, M.A., B.Sc., M.I.E.E., director of research and education, A.E.I. (Rugby) Limited, Rugby; Mrs. Elsa Dunbar, member of the London Electricity Board; Mr. Noel Newman, President of the Joint Iron Council since 1954, and chairman and managing director of Newman, Hender & Co. Ltd.; Mr. S. Green, A.M.I.E.E., M.I.Prod. E., managing director, Remploy Limited; Mr. A. J. Nicholas, O.B.E., managing director South Wales Switchgear Limited; and Mr. J. Sharples, B.Sc. (Eng.), M.I.E.E., general manager and deputy chairman, Central Electricity Board, Federation of Malaya. Officers of the Order (O.B.E.) include Mr. T. Barlow, resident engineer, Windscale Works, Cumberland, United Kingdom Atomic Energy Authority; Mr. J. S. Hales, director of the Industrial and Domestic Development Laboratories of the British Coal Utilisation Research Association; Mr. E. J. Timberlake, Associate I.E.E., joint managing director of the Electro Dynamic Construction Co. Ltd.; and Mr. J. E. Whittaker, B.Sc. (Eng.), M.I.E.E., A.I.Mech.E., M.Inst.F., manager, Aberdeen area, North of Scotland Hydro-Electric Board.

GENERAL CONDITIONS FOR EXPORT CONTRACTS

A new Model Form of General Conditions of Contract, known as "B2 (1960): Export Contracts, Delivery F.O.B., C.I.F., or F.O.R., with Supervision of Erection," has been prepared by the Joint Committee on Model Forms of General Conditions of Contract of the Institution of Mechanical Engineers, and the Institution of Electrical Engineers, and published under the authority of the councils of these two Institutions. Following an approach

in 1952 by the Association of Consulting Engineers, it was agreed that this Association should adopt and recommend to its members the use of this model form of general conditions of contract and the name of the Association accordingly appears on the title page of the document. This new Model Form now takes the place of the I.E.E. Model Form B2 (1928) (which has been withdrawn) for export contracts which include delivery and supervision of erection of electrical plant. Likewise, for export contracts including delivery and complete erection, Model Form B2 (1928) has been superseded by Model Form B3 (1954). Thus, the complete range of Model Forms issued jointly by the two Institutions is as follows:—"B1 (1956) Export Contracts, Delivery F.O.B. or C.I.F." Price 4s. 6d. "B2 (1960) Export Contracts, Delivery F.O.B., C.I.F., or F.O.R., with Supervision of Erection." Price 4s. 6d. "B3 (1954) Export Contracts, including Delivery to and Erection on Site of Electrical and Mechanical Plant." Price 5s. Copies of these publications can be obtained from the Secretary of the Institution of Mechanical Engineers, 1, Birdcage Walk, London, S.W.1, or the Secretary of the Institution of Electrical Engineers, Savoy Place, London, W.C.2, at the prices quoted, which include postage.

B.I.M.C.A.M. The annual luncheon of B.I.M.C.A.M. (The British Industrial Measuring and Control Apparatus Manufacturers' Association) was held in London on Tuesday, January 19th, when some 170 members and guests were present. Mr. W. G. Thomas (Bailey Meters & Controls Limited), the President of the Association, presided, and the principal guest was Mr. C. Robertson King, C.B.E., chairman of the Electricity Council. Following the Loyal Toast, the Toast, "The Association," was proposed by Mr. King, who, in his address to the gathering, spoke of the continued good work of the Association and its members, and mentioned the vast difference in the present-day application of the instrumentation equipment and other products of the members of the Association, in the power generating industry, and in industry in general, as compared with that of a few years ago. Today, the vast saving in labour and operating costs as the result of efficient instrumentation is obvious to everyone. Mr. King also referred to the rapidly increasing amount of instrument application in the nuclear power field. He congratulated the Association on the progress made, and wished both the Association and its members continued success in the future. The toast was responded to by Mr. V. D. MacLachlan (Honeywell Controls Limited), and chairman of B.I.M.C.A.M. He thanked Mr. King for his complimentary remarks regarding the Association and said that the member firms must in the future extend still further their efforts and services to meet the growing requirements of automation in all forms of industry. Mr. MacLachlan said that the industry's turnover figures had, since 1944, grown from £3 million to £35 million, and added that it was satisfactory to note that the export percentage of the total was much higher than the national average. He foresaw that the trend towards shorter working hours and greater consumer demand could only be met by the increased use of instrumentation. The Toast, "The Guests," was proposed by Mr. Thomas, the President, who welcomed, and named, some of the principal guests, and the toast was replied to by Mr. S. W. J. Wallis, M.Inst.Pet. (The British Petroleum Co. Ltd.). B.I.M.C.A.M., which was inaugurated in January, 1944, is an association of British manufacturers of industrial instruments for measurement and automatic control, freely uniting in their common interest to further the development and efficiency of their industry. The Association is the recognised point of contact with the manufacturing industries and public authorities who use its members' products, and contains within its membership, the most important firms in the United Kingdom engaged in industrial instrumentation.

BABCOCK & WILCOX CHAIRMANSHIP At a board meeting held on January 12th, Mr. W. Lionel Fraser, C.M.G., in accordance with an earlier intimation, formally requested his colleagues to accept his resignation from the board of Babcock & Wilcox Limited, to become effective after the annual general meeting on May 26th next. Mr. Fraser recalled that in July of this year he would have served a period of ten years as chairman, as was always envisaged. Moreover, the deputy chairman, Sir Kenneth Hague, would have fulfilled his term of office as President of the Engineering and Allied Employers' National Federation, at the end of February. The board accepted Mr. Fraser's resignation, and appointed Sir Kenneth Hague as chairman from May 26th. The directors also appointed Sir Reginald Verdon Smith as deputy chairman as from that date. In order to retain Mr. Fraser's advice and experience, and in acknowledgment of his service, the directors decided to submit a resolution to the stockholders at the annual general meeting for the creation of the position of president of the company. If approved, they propose to invite Mr. Fraser to accept the appointment.

STANDARDS ENGINEERS A new publication by the British Standards Institution provides a guide to the principles and practice of applying standards in the individual firm. The booklet, "The Operation of a Company Standards Department," could have been sub-titled "How to be a Standards Engineer." It is primarily addressed to the engineer who has been delegated to set up a standards department. It is hoped that it will also be of use to management, colleges and the established standards engineer. The booklet is sponsored by a joint committee of the B.S.I. and the Institution of Production Engineers, and the draft was presented to the last standards conference for comment. The booklet describes the functions of a company standards department and an outline is given of the fields covered by company standards and variety reduction. Advice is given on the actual writing of company standards and the means of making these standards effective. The importance of classification and coding in standards work is explained and the general principles are outlined. The layout and headings for a model standards sheet are outlined. Copies of this booklet (Ref. No. PD 3542) can be obtained from the British Standards Institution, 2, Park Street, London, W.1. Price 3s. It will also be on sale at H.M. Stationery Office, Kingsway, London, W.C.2.

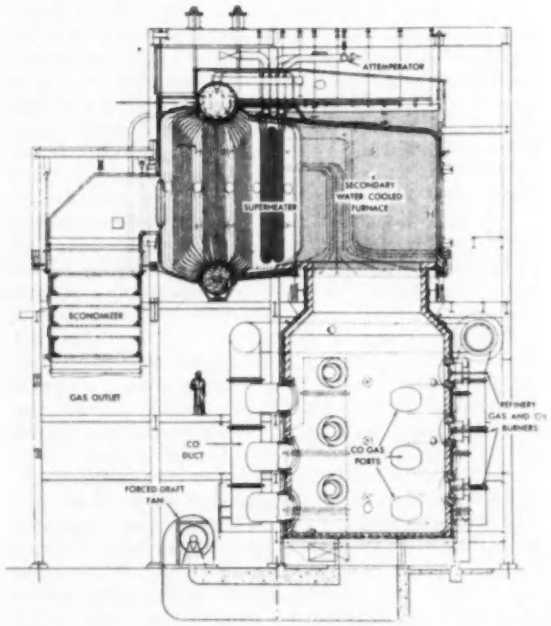
Fluid Coke Firing of Large Boilers

Following exhaustive experiments, a form of fluid petroleum coke, which is the end product of a new oil-refining process, is being used for firing the specially-designed furnaces of the boilers in an American power station

A NEW type of fuel, known as fluid-coke, is being used to fire the three boilers installed at the Delaware City station of the Delaware Power & Light Company. The supply of this fuel forms part of an exchange arrangement between the power company and the Tidewater Oil Company, whereby the former provides the refinery with 18,000 to 40,000-kW of electricity, together with 300,000 to 800,000 lb./hr. of process steam and treated water, and receives in return, the new fluid-coke, together with supplies of oil-fuel, well-water and cooling-water. The Tidewater refinery stands adjacent to the Delaware City power station, and both plants were designed and constructed by C. F. Braun & Co., of Alhambra, California, in collaboration with the oil and power companies' own engineers. Process steam is the main product of the power station; only about 15 per cent. of the energy produced being converted into electric power.

Fluid petroleum coke is the end product of a new refining process developed by the Esso Research and Engineering Company, that is claimed to yield more petroleum and distillate fuel than was possible with earlier processes, and at the same time allows the lowest crude oils to be processed. Though containing, due to agglomeration, occasional lumps up to 1½-in. diameter, the new fluid-coke is made up of small, very hard spherical particles. A typical mesh analysis would be:—up to 48 mesh size, 5 to 10 per cent.; size 48 to 100, 30 to 50 per cent.; size 100 to 200, 30 to 50 per cent.; size 200 up, 10 to 20 per cent. Clean, comparatively dustless and pouring freely, with the low angle of repose of about 30 deg., it has many of the handling characteristics associated with a fluid, and can easily be transported pneumatically by pipeline. It contains little volatile material, this usually being in the region of 4 to 8 per cent. by weight. Although the analysis of fluid-coke depends on the crude-oil from which it is produced, a typical analysis might yield the following values:—sulphur content, by weight, 6 to 8 per cent.; ash, by weight, 0.2 to 1.0 per cent.; moisture, by weight, 0.3 to 1.0 per cent.; vanadium 0.1 per cent.; chlorides 0.007 per cent. and carbon, by weight, 90 to 94 per cent. The ignition temperature of the new fuel is approximately 1,400 deg. F., while it has a gross heating value of over 14,000 B.Th.U./lb., burning with less than ½ per cent. fly-ash. Its ash fusion point is from 2,500 to 2,900 deg. F., but, here again, this will vary with the crude source.

The residue obtained from the bottom of refinery vacuum towers is used to produce the fluid-coke. This residue is fed to a reactor, where it is sprayed on to recirculated fluid-coke already in the reactor. The liquid feed remains on the coke particles and is held at a temperature of approximately 950 deg. F., until it thermally cracks to form lighter materials and more coke. All the coke produced in the reactor passes to a coke-burner, which is designed to provide about 400 million B.Th.U./hr. of heat to the reactor when burning approximately 20 per cent. of the gross coke made, and returning some 44 ton/min. at a temperature of 1,125 deg. F., to the reactor. A 6,870-h.p. centrifugal-blower is provided to supply 100,000 cu. ft./min. of combustion air to the coke-burner. Coke fines in the burner flue gases, which are not removed by the action of the two-stage cyclones provided prior to the flue-gas outlet, pass, together with appreciable amounts of carbon monoxide, to a CO boiler supplied by The Babcock & Wilcox Company, New York. When the burner is not in use, the CO boiler can be fired by either fuel-oil or gas, and will then generate 210,000 lb./hr. of steam at 600 lb./sq. in. and 750 deg. F. When both the reactor and coke-burner are operating, steam production is 426,000 lb./hr.



Outline arrangement of the Babcock & Wilcox CO boiler, which operates in conjunction with the coke-burner at the Tidewater oil refinery Delaware City, U.S.A.

The net coke product is delivered either direct to the power station or to storage at the refinery. Delivery to the power station is effected pneumatically through three 5-in. pipelines, one for each boiler, at a rate of 75-tons/hr., using 2,600 cu. ft./min. of air at 90-lb./sq. in. and 100 deg. F. These pipelines deliver the coke to three 1,100-ton capacity steel silos located on the roof of the

station. The silos are vented through bag-filters to remove any dust, and are fitted with 60° conical bottoms for the future handling of coal, if required.

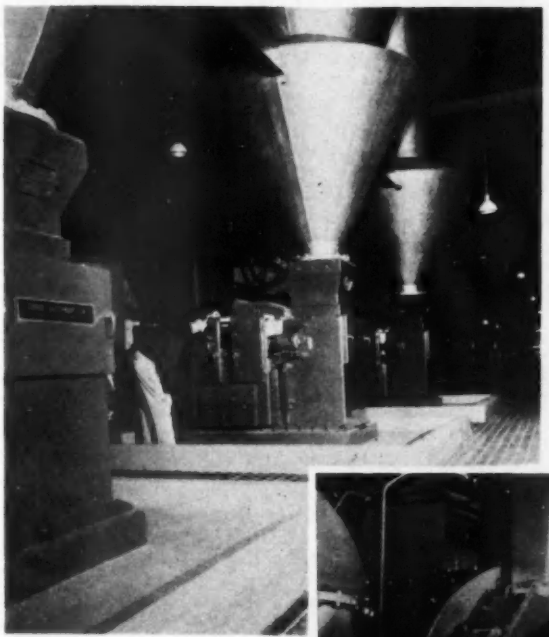
From the silos, the coke passes over automatic continuous-type scales to star-type coke-feeders similar to those used for coal, but having closer tolerances. From the feeders, which are at operating-floor level, the coke is gravity-fed to Riley duplex attrition-type pulverisers at ground-level, where it is reduced in size to about 80 per cent. through a 200-mesh screen. Three duplex pulverisers are provided for each of the three boilers and, because of the abrasive nature of the coke, all the grinding elements are faced with tungsten carbide.

Power station boiler plant

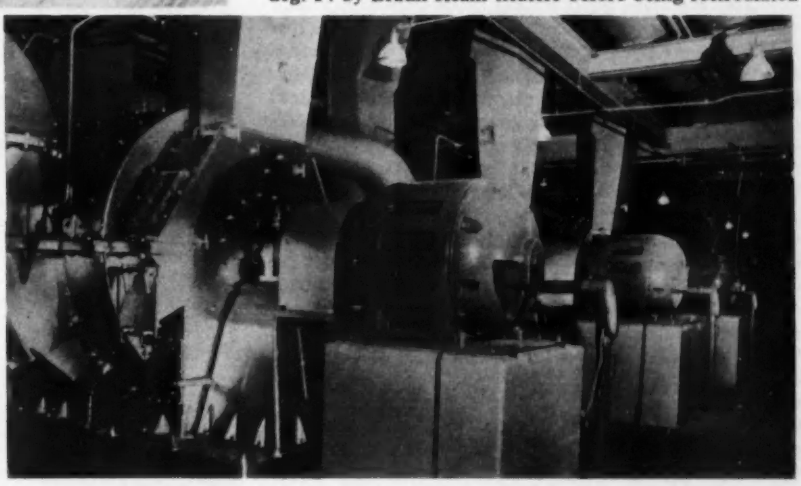
Designed specifically for the new fuel, the three boilers supplied by the Riley Stoker Corporation each have an m.c.r. of 500,000 lb./hr., at 1,300 lb./sq. in. and 950 deg. F. They are of outdoor construction, only the firing-aisle and the floor at drum-level being enclosed for the protection of operating staff. The boilers are of the two-pass, slag-bottom, turbo-furnace type, and to achieve maximum combustion temperatures the front and rear walls are " pinched-in " to allow the burners to fire at an inclined angle over a fill of high-silica sand covering the hearth floor. It was considered that combustion would be unstable without a 10 per cent. supporting flame, and the boilers were, therefore, designed to burn a second fuel. This is normally refinery gas, but oil-burners are also provided as a safeguard against a gas supply failure. Combustion controls are, in fact, arranged to ensure that the oil-burners are at all times operating on a low rating ; the normal pattern of combustion being 88 per cent. fluid-coke, 10 per cent. refinery gas and 2 per cent. oil. The possibility of using pulverised-coal at some future date was allowed for at the design stage, and space is available for the addition of coal-crushing and conveying equipment, railway sidings, etc.

Twelve burners are provided for each boiler, the individual burners incorporating three pulverised-fuel nozzles, two gas-burners and a wide-range oil-gun. By using a large number of small nozzles, the fuel surface area exposed to the radiant heat of the flame is much greater, and this is considered to be an important feature in view of the high ignition temperature of the fluid-coke. The burners are mounted approximately 10-ft. above the level of the sand in the hearth to give opposed firing downwards through the boiler-arch into the slag-pool. Fly-ash from certain crude-oils has a very high fusion temperature, and because of this, the furnaces are provided with means for the addition of a flux, such as calcium oxide or magnesium, to the slag-bottoms. Depending on the fuel combination being fired, the primary-air supply to the burners is at a temperature of approximately 600 deg. F.

Since the gas produced at the refinery has a heat content of 1,000 to 1,100 B.Th.U./cu. ft., an automatically-operated valve has been installed to cut off the supply to the generating station, should the pressure in the gas supply main fall below 100-lb./sq. in. The valve is, however, provided with a by-pass so that gas for ignition purposes only is available, in the event of such a pressure drop. Any moisture present in the gas is removed in a separating tank. The oil used at the Delaware power plant is Bunker " C " oil obtained from the refinery's catalytic-cracker, and this is preheated to 120 to 130 deg. F. by Braun steam-heaters before being recirculated



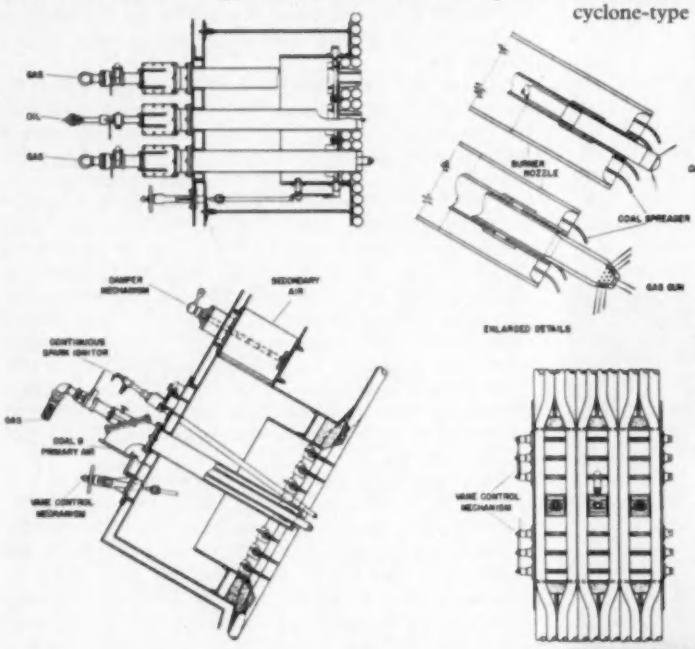
(Above). View showing the base of the fluid-coke silos feeding into automatic continuous-type scales.



(Right). Three Riley duplex attrition-type pulverisers are provided for each boiler. They reduce the fluid-coke to approximately 80 per cent. through a 200-mesh screen.

to either of two 1,182,000 gallon capacity storage tanks.

Each boiler has a two-section, pendant-type superheater with means for desuperheating between the sections; the superheaters being suspended from outside, and hanging freely inside the furnaces. Superheat temperatures are controlled at 950 deg. F. by a desuperheating water-valve on each superheater; the water spraying into the loop between two of the headers. Since they are centrally-supported at about lower drum-level, the boilers can expand both upwards and downwards. An inner steel casing is provided to protect the boiler insulation, which consists of 3½-in. of monobloc in two layers



(Left). Diagrammatic arrangement showing details of the Riley directional-flame burner for firing pulverised-fuel, gas and oil.

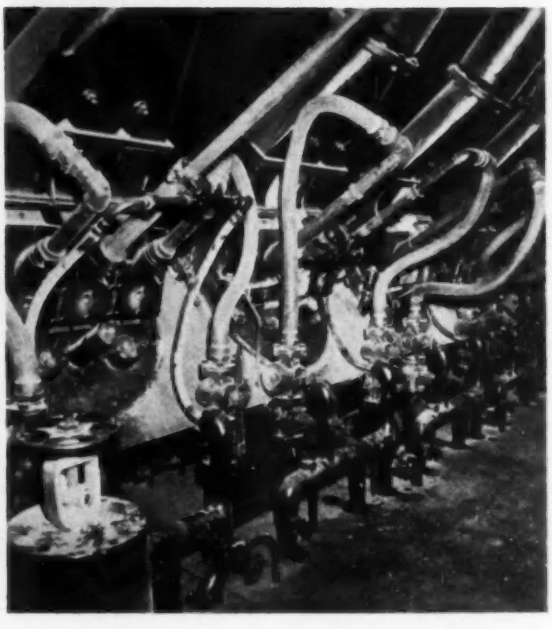
between the inner case and the outer shell. The latter is secured with batten straps and painted to prevent corrosion. Originally, a slag-notch with a clay-plug was provided for slag draw-off, but in operation the slag-bottom was found to run dry, and a powder-lance is now used for tapping. The reason for the incorporation of a slag-bottom furnace was to obtain higher temperatures and a greater turbulence, thereby achieving more complete combustion. The general heat release over the whole furnace is approximately 17,000 to 19,500 B.Th.U./cu.ft./hr. but, in the combustion zone itself, the heat release is 84,000 to 96,000 B.Th.U./cu.ft./hr.

While the furnace is completely water-cooled, with the lower 15-ft. portion of the tubes coated with chrome ore, the hearth is air-cooled, and has free-standing firebrick walls. Air under pressure passes through built-in ducts to cool the hearth bottom, before being exhausted to atmosphere on the opposite side of the furnace. Silica sand with a fusion temperature of about 3,000 deg. F. has been poured above the hearth floor to a depth of 2½-ft. at the centre and 4-ft. at the sides. Hearth temperatures are measured by thermocouples, twenty-four of which are mounted under each hearth and connected to an auxiliary instrument panel located alongside each boiler. As a means of protecting the tubes, Dolomite is blown into each furnace, just above the combustion zone, through three nozzles in one of the furnace walls. The rate of Dolomite feed per cubic foot of transport air is controlled to suit the fuel analysis by the use of a rotary-screw variable-speed conveyor which feeds the Dolomite from a bin. The entraining air is supplied by a positive-displacement blower.

Each boiler is provided with a vertical Ljungström air-heater; one f.d. and one i.d. Westinghouse/Sturtevant fan; two Yarway bi-colour remote level-indicating sight-glasses, a Bailey water-level recorder and a Yarway level-indicator in the control room; and a Prat-Daniel cyclone-type mechanical dust-collector. The material collected in this latter unit may contain a large percentage of carbon, and it is, therefore, recycled back to the pulverisers. Space has been provided for the installation of a second precipitator, between the i.d. fan and the chimney, if this should be required.

The three boilers are served by a single chimney, 500-ft. high, with an internal dia. of 32-ft. at the base, and 20-ft. at the top. Due to the sulphur content of the fluid-coke which may reach as high as 6 to 8 per cent., it was necessary for the chimney to be exceptionally high, in order that any SO_2 fumes would be dispersed safely. The chimney is designed to serve a fourth boiler of similar size should this be constructed in the future.

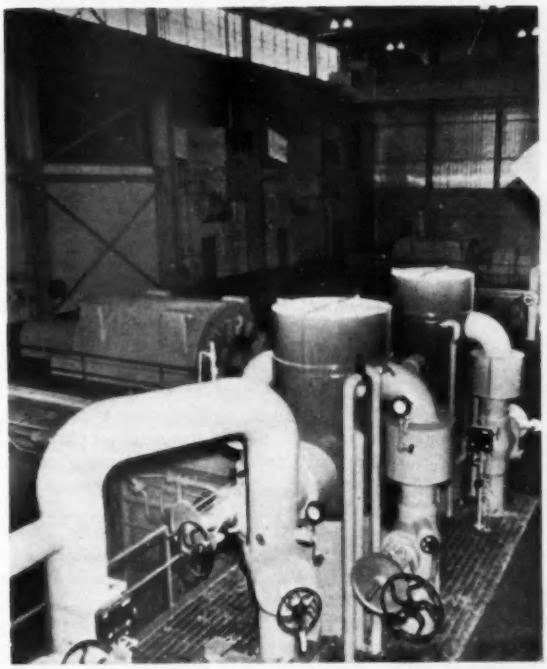
(Below). View of boiler fronts, showing burner feed lines for fluid-coke, gas and oil. The boilers are designed to burn all three fuels.



Built of reinforced-concrete, the chimney has an acid-proof lining throughout, and a hopper-bottom below the breeching entrance. The breeching has been sprayed with lime-base paint in order to slow down the rate of corrosion.

Steam distribution

Steam from all three boilers is collected in a common 14-in. header system at 1,300 lb./sq. in. and 950 deg. F., and discharged through automatically-controlled valves at three pressures to the refinery;—at 600 lb./sq. in. and 750 deg. F. for use in the large steam turbine drives, such as the catalytic-cracker air-blower and the gas



View in the turbine house, showing the two 25-MW extraction-converting turbo-alternator sets. These are both designed for steam conditions at the turbine stop-valve of 1,250-lb./sq. in. and 950 deg. F.

compressors; at 175-lb./sq. in. and 425-deg. F. for quenching and process work; and at 40-lb./sq. in. and 380 deg. F. for process work, space-heating and steam-tracing. Of the 800,000 lb./hr. of 600 lb./sq. in. steam sent to the refinery, the equivalent of some 180,000 lb./hr. is returned to the power plant as condensate after the extraction of over 95 per cent. of its heat value.

It was the original intention when designing the refinery to utilise electric drives to the greatest possible extent, with steam turbine drives reduced to a minimum. In practice, however, there are 80 steam-driven turbines out of a total of 530 power drive units, and although this represents only about 15 per cent. by number, it does represent a far larger percentage of the total horsepower. For the first time in such a large refinery, emergency steam drives have been kept to a minimum because of the high degree of reliability expected from the electrical distribution system. When, however, a steam-driven standby drive was selected, the first criterion was whether or not 40-lb./sq. in. pressure steam would be required in that area for other uses, such as process work, space-heating or tracing. If so, then the most critical drive unit in that area was selected for turbine standby to help balance the steam load. Otherwise, an electric standby was installed with an alternative source of power. For large units such as the catalytic-cracker air-blower and the reactor air-blower, steam turbine drives were preferred as being more efficient in operation. Rather than accept a loss by utilising steam to drive a turbo-alternator set to produce electricity, 600 lb./sq. in. steam was used directly in these few large turbine units where the water rate was similar to the turbo-alternators installed in the power station.

Although the primary objective of the Delaware City power plant is to provide steam for the adjacent refinery, some 15 per cent. of the energy produced is used for electricity generation, the entire output from the station being delivered to the refinery. The generating plant installed comprises two General Electric extraction-converting turbo-alternator sets, each rated at 25,000-kW at 3,600 r.p.m., and designed for maximum steam conditions at the turbine stop-valve of 750,000 lb./hr. at 1,250 lb./sq. in. and 950 deg. F.

Water supplies

The combined power station and refinery requires sufficient cooling-water to remove a heat load of 3,000 million B.Th.U./hr., in addition to water for various other purposes including boiler make-up. Four water systems are used. One supplies river water for cooling purposes on a once-through basis, and has been designed to provide for a maximum delivery at peak loads of about 310,000 gal./min. The three other systems deliver well-water at a rate of 2,600 gal./min. to a water-treatment plant; at 540 gal./min. as raw water make-up for the process units; and at 300 gal./min. for fire-fighting water make-up. The delivery of process steam to the refinery increases the power station water make-up requirement to about 40 per cent.

In the cooling-water system there are, of course, no cooling towers and water-treatment is limited to chlorination. The system has been designed with the special requirements of reliability, flexibility and durability in mind. All parts of the system have been duplicated with the exception of the inlet and outlet channels and the separator, and thus continuity of supply has been assured. The demand, which can vary from 140,000 to 275,000 gal./min., is met by nine Byron-Jackson vertical centrifugal-pumps, each with a capacity of 34,400 gal./min. against a discharge pressure of 80-lb./sq. in. The pumps are all driven by 2,000 h.p. Allis-Chalmers electric motors.

Well-water is obtained from nine wells, and before use passes through a water-treatment plant in which it is subjected to aeration, coagulation, clarification, gravity filtration, chlorination and chemical treatment. A 1,100 gal./min. Zeolite softener is provided for process water, and a 1,500 gal./min. demineraliser for the boiler feedwater supply which is then mixed with boiler condensate, already treated for re-use.

High Efficiency Axial-Flow Gas Compressor

WHEN the high-pressure distribution system of the Birmingham Division of the West Midlands Gas Board, which serves districts mainly to the south and south-west of the city, was extended during the period 1954 to 1957, a new compressing station was established at Washwood Heath. The compressor installed at the station is of particular interest, in that it is of the axial-flow type instead of the centrifugal or reciprocating type previously used for such duties. The axial-flow compressor, which has a capacity of 600,000 cu. ft./hr. at a maximum pressure of 25-lb./sq. in., was supplied by W. H. Allen, Sons & Co. Ltd., Bedford, and the design was based on the company's experience in the construction of marine gas-turbines incorporating similar units. Modern methods of automatic control have also been incorporated, so that, in addition to a high efficiency, a reduction in size compared with conventional types, and freedom from noise and vibration, the machine will accommodate all changes in gas demand under fully-automatic control.

The compressor is driven by a constant-speed 3,000-V, 3,000 r.p.m., 1,150-h.p. squirrel-cage induction-motor, through a Vulcan-Sinclair fluid-coupling, and an Allen/Stoeckicht speed-increasing epicyclic gear. This combination is claimed to provide a very flexible transmission and high-efficiency at full-speed, since the motor efficiency is 94-96 per cent. at a power factor of 0.9-0.91, the fluid-coupling efficiency is 98 per cent., and the gear efficiency also 98 per cent. The complete unit is mounted on a fabricated base-plate which also acts as an oil tank. Oil is supplied to the plain bearings at 30 lb./sq. in. and to the control-gear at 70 lb./sq. in. by an electric-motor-driven gear-pump connected to the same electrical circuit as the driving motor. A standby motor powered by an independent supply is also provided. The fluid-coupling, which is fitted with its own centrifugal pump, is a size 20 ST5 fluid-coupling, supplied by Fluidrive Engineering Co. Ltd., and is of the scoop-trim type, transmitting 1,150-h.p. at 2,950 r.p.m. The infinitely-variable speed range is from 2,870 r.p.m. down to 1,735 r.p.m. with automatic control. The maximum compressor speed is 1,900 r.p.m., and an important function of the fluid-coupling is to enable the motor to run up to speed very rapidly, and the compressor to be accelerated smoothly over a period of time, which limits the loading on the speed-increasing gear, etc. The time required, and the high starting current for the motor are thereby greatly reduced.

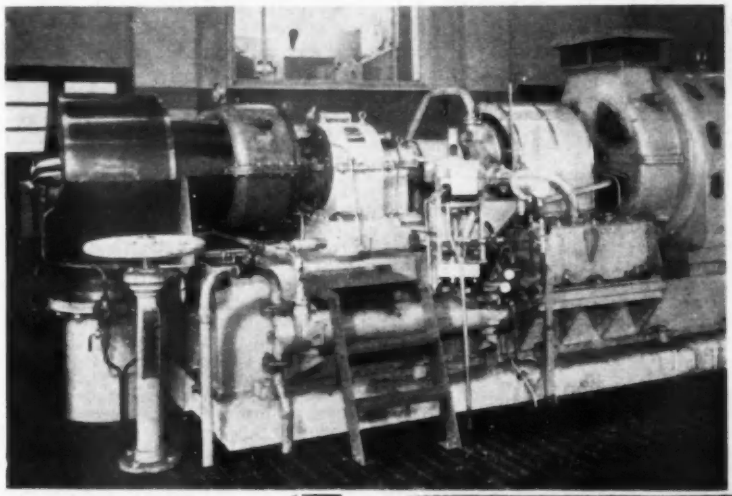
When designing the compressor, special attention was paid to sealing the blading against oil-leakage from the compressor bearing glands, and in addition, the gland spaces are evacuated by an extractor pump located in the compressor-house basement. To cool the gas, which leaves the compressor at a temperature of approximately 130 deg. C., a Serck cast-iron, tubular cooler is provided; the necessary water for this unit and for the oil-coolers fitted in the base-plate is supplied by centrifugal-pumps from a water-pond associated with conventional cooling-towers.

The unit comprises fourteen compression stages, each consisting of one row of rotating blades and a row of stationary blades. Each rotor blade is located in an axial groove, and twisted from root to tip in order that they should meet the gas at the correct angle at all radii. The axial velocity is maintained constant throughout the blading at approximately 450 ft./sec., while the components of velocity vary in accordance with the velocity triangles. The stator blades are located in circumferential slots, and there are, in this case, sixteen rows of blades. One additional row is provided at the compressor gas outlet to act as flow straighteners before the gas passes into the outlet diffuser where more velocity energy is converted into pressure energy. Any swirl in the diffuser would destroy its efficiency and reduce its contribution to the total increase in pressure. The other extra row is at the inlet and these blades function as inlet guide vanes which direct the gas at the correct angle to the first row of rotating blades. All the blades are machined from an aluminium-bronze material which has good fatigue and anti-corrosion properties. Any leakage of gas between the tips of the blades and the casing would reduce the operating efficiency and the tip clearance has, consequently, been reduced to an absolute minimum consistent with safety. The minimum cold-tip clearance is 0.015-in., whilst the minimum axial clearance between the rows is 0.035-in.

Before the compressor left the Allen works at Bedford, various tests were undertaken, a complete calibration on air being made to cover the equivalent gas-working range, and to check that the design was capable of giving the required throughput. The compressor was also momentarily surged at several speeds in order to check the position and shape of the surge line, and in addition, aerodynamic tests were undertaken on the compressor inlet, where any flow irregularities would be undesirable as they could possibly produce blade flutter, leading to fatigue failure. Certain fairings and streamlining of struts, etc., was suggested by the results obtained from these tests, and the flow conditions to the inlet guide vanes and first row of rotating blades were considerably improved. During this period, strain gauges were fitted to four stator blades in the first, ninth and fourteenth stages, to investigate blade vibration and bending stresses under operating conditions. In order to interpret the results subsequently obtained from an oscilloscope, it was necessary to obtain a calibration by exciting one blade in a rig by means of a jet of compressed-air directed at the tip.

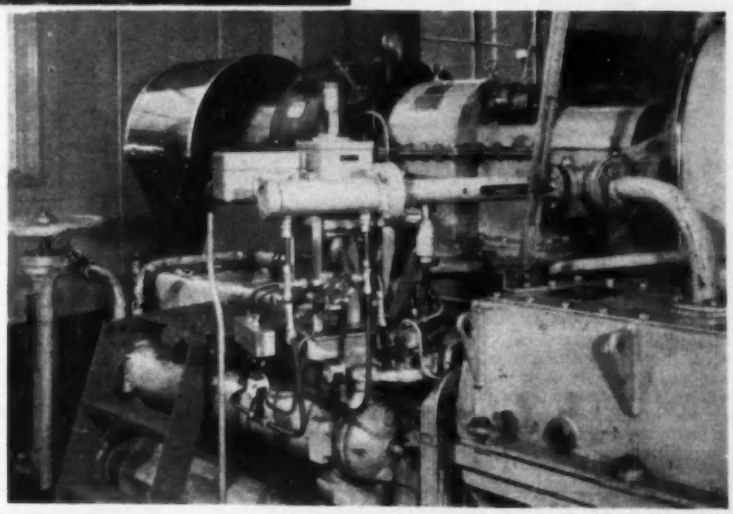
The compressor calibration was repeated on site under normal operating conditions, although gas could not, of course, be passed into the mains, but was recirculated back into the compressor inlet through a by-pass valve. By adjusting this valve, the back-pressure on the compressor could be increased and the constant speed lines

plotted. The compressor was again momentarily surged, and the position of the surge line checked. Photographic and visual observations were made from the strain gauges on an oscilloscope, and the stresses and frequency of vibration were found to be of a very low order under all conditions. The adiabatic efficiency of the compressor was, at the same time, calculated from the measured temperature rise, and the calculated temperature rise based on the measured pressure ratio. This was found to be between 82 and 88 per cent. over the useful working range of the compressor.



(Left). The 14-stage, 600,000 cu. ft./hr., 1,900 r.p.m. Allen axial-flow compressor driven by a 1,150-h.p., 3,000 r.p.m. squirrel-cage induction motor through a fluid-coupling supplied by Fluidrive Engineering Co. Ltd. and an Allen-Stoeckicht epicyclic speed-increasing gear.

(Below). This view of the compressor shows the Evershed & Vignoles Limited scoop-tube positioner controlling the output speed of the fluid-coupling.



Control equipment

A requirement of the plant was that it should be capable of automatic adjustment to meet the variations in gas demand throughout the day. To achieve this flexibility, two basic control systems were provided. These were supplied by Evershed & Vignoles Limited, and comprised equipment for both speed-control and flow-control. Speed-control is necessary because, as the gas demand increases, the pressure in the mains falls, with the result that the compressor speed must be increased to compensate for this. Conversely, if the demand falls, the mains pressure will rise and the compressor speed must be reduced. For this purpose, a proportional-control system was provided, in which the current output from a proportional controller is supplied to an electro-magnetic head. This unit converts the electrical signal (in milliamps) into a force which operates the jet-pipe in an Evershed jet pipe controller. The latter operates on the principle that when a jet of oil issuing under pressure from a nozzle impinges on a surface at right-angles to the direction of flow, its forward velocity is destroyed, and a pressure is set up on the surface. The surface in this case has two orifices drilled into it so that when the jet-pipe is mid-way between the two, the pressure in each passage leading from the orifices to opposite sides of a piston is equal. When the jet-pipe moves under the action of the electro-magnetic head, a pressure difference across the piston is created which causes the piston to move; this becomes the mechanical action required to move the scoop-tubes in the fluid-coupling, and change the output speed of the coupling.

It has already been emphasised that the compressor must not be operated in a surged condition, as such a condition will certainly exist on starting-up, shutting-down and during some periods of steady operation when the required flow is small and the pressure is high. Under these circumstances, more gas than is required must be compressed and the surplus is by-passed back to the compressor inlet. This is fundamentally inefficient but increases the scope and flexibility of the plant to face a variety of operating conditions. The main item in the flow-controller system is again the Evershed jet-pipe device, but in this case, there are two variables, viz.—flow and pressure. Instead of an electro-magnetic head a diaphragm unit, the pressure differential across which represents the flow, and a bellows-operated cam,

sensitive to the delivery pressure are required to move the jet-pipe between the two orifices. A similar piston operating through a cranked lever then operates the by-pass valve.

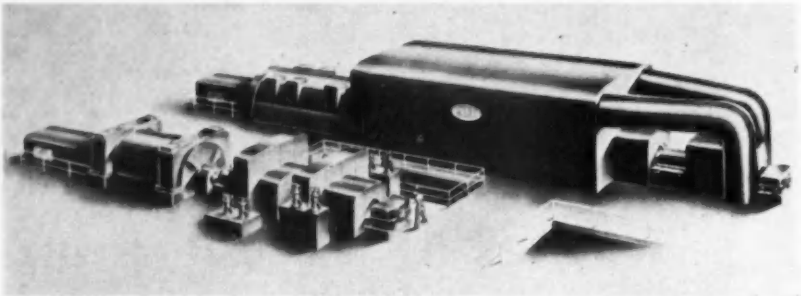
Due to the lack of operating experience with this type of gas compresssor, and the overriding importance of preventing the establishment of surge conditions, a surge-control unit was also included. This has two functions. It is arranged to lock the speed of the compressor before the operation of the automatic by-pass valve, in order to meet the dynamic characteristics of the whole system; and secondly, in the event of the by-pass valve failing to open, and the compressor continuing to move towards surge, an emergency by-pass valve, in parallel with the main by-pass valve, is brought into operation.

The gas handled by the compressor has been found to deposit a brown, slightly moist powder on the blading, and as this condition would eventually affect the plant efficiency, provision has been made to clean the blades, while the compressor is in operation, by the injection of benzene. For this purpose four sprayers have been built into the gas inlet and these are supplied with benzene from a storage-tank, through a semi-rotary, manually-operated pump. This method of cleaning has proved to be satisfactory and a daily cleaning routine has now been established. The compressor is run up to its minimum speed, and then shut down. During this period, which occupies approximately 3 min., benzene ir injected.

In the near future a second and similar compressor, already ordered and under construction, will be installed at Washwood, and the two machines arranged for running in parallel.

SECOND 550-MW GENERATING SET ORDERED FOR THORPE MARSH

The second 550-MW turbine-generator for installation in the Central Electricity Generating Board's Thorpe Marsh power station, now under construction, near Doncaster, is to be ordered from Associated Electrical Industries Limited. This generating set will be the largest two-speed conventional cross-compound machine in the world generating at 50 c/s. The total value of the contract will be approximately £3½ million, and the design and manufacture will be carried out at the Trafford Park Works of the A.E.I. Turbine-Generator Division. The unit is expected to operate with an overall station efficiency some 7 per cent. better than the most efficient station listed in the C.E.G.B.'s last annual report—viz. Castle Donington where six A.E.I. 100-MW turbine-generators are installed—and about 14 per cent. better than the average of the twenty most efficient C.E.G.B. stations listed in the report; thus demonstrating the remarkable advance in the design of steam turbine-generator plant. The turbine-generator will consist of a multi-cylinder steam turbine, from the boiler, at a pressure of 2,300 lb./sq. in. and at a temperature of 1,050 deg. F. will be expanded through the h.p. cylinder, and reheated to 1,050 deg. F. before expanding through the first i.p. cylinder. Leaving the high-speed line, the steam passes over to twin second i.p. cylinders on the low-speed line, and thence to the l.p. cylinders, before exhausting to the condensers. The two generators, although of equal output, will differ in size because one will run at 3,000 r.p.m. and the other at 1,500 r.p.m., but both will have water-cooling of the stator windings, a system introduced by A.E.I. The cooling-water is circulated through the live conductors, which are made from copper in the form of thick-walled tubes of rectangular cross-section. The remaining parts of the generators are cooled by hydrogen at a pressure of 30-lb./sq. in. The hydrogen will be circulated inside the sealed casings of the generators by fans mounted on the ends of the rotors. The gas will be forced through ducts in the stator core, and through the rotor, where it will be brought into direct contact with the copper of the rotor windings. The hydrogen will be cooled before recirculation by banks of water-cooled tubes within the generator casing. Generator units with two-speed cross-compound turbines have been produced previously at Trafford Park. The most notable were the two 110-MW machines installed at Battersea station, by Metropolitan-Vickers Electrical Co. Ltd., the first of these sets having been in operation now for nearly twenty years.



Artist's impression of the 550-MW turbo-generator to be supplied to Thorpe Marsh power station of the C.E.G.B., by A.E.I. (Manchester) Ltd.

divided into two sections on two separate lines, each driving a 275-MW a.c. generator delivering three-phase power at the standard frequency of 50 c/s. The two sections of the turbine will be cross-compounded with a single-flow high-pressure cylinder and a double-flow first intermediate-pressure cylinder on one line running at 3,000 r.p.m., and two single-flow second intermediate-pressure and two double-flow low-pressure cylinders on the other line running at 1,500 r.p.m. Steam

NUCLEAR POWER STATION FOR SUFFOLK

The Central Electricity Generating Board have been informed that the Minister of Power has decided to give his consent to the building of a nuclear power station at Sizewell, Suffolk. With a planned output of 650-MW, the station will be larger than any of the nuclear stations now under construction. The Sizewell site comprises slightly more than 200 acres of land, none of which is of high agricultural value, the area being sufficient to permit extension of the station if required in the future. The East Suffolk County Council granted planning permission for the station some nine months ago, and the Generating Board gratefully acknowledge the co-operation and help of the Council during the unitial investigation and subsequent negotiations. Tenders are being sought forthwith from the consortia of companies engaged in nuclear power station construction work, and preparatory work will be carried out on local access road improvement. Four nuclear power stations are, of course, at present being constructed for the Central Electricity Generating Board at Bradwell, Essex (300-MW); Berkeley, Gloucestershire (275-MW); Hinkley Point, Somerset (500-MW); and Trawsfynydd, Merionethshire (500-MW). The Generating Board has received consent for a fifth station at Dungeness, Kent (500-MW) and consent is being sought for a 1,000-MW station at Oldbury, Gloucestershire.

Proposed Method for the Control of Marine Fouling

By L. SZEGO*

SMALL concentrations of active chlorine are used successfully for the control of marine growth in sea water as used for cooling purposes in steam turbines. Usually, this is achieved by carefully controlled addition of chlorine gas to the water in the inlet conduit. The chlorine may be purchased in liquid form in cylinders. Alternatively, it can be produced from brine solution[1] or ordinary sea water by direct current electrolysis[2,3]. In either case, elaborate equipment is required for proper dosage, and the usual precautions and corrosion problems connected with the use of chlorine gas must be met. While electrolysis of the sea water itself would avoid the handling of chlorine or strong chlorine solutions, no such process used at any power station has so far been reported in available literature. Most probably the reason for the absence of such electrolysis in practice lies mainly in the excessive cost of rectifying equipment required for the very high currents, and partly in the anodic corrosion and cathodic deposition of basic magnesium compounds. R. J. Hopkins[4] has suggested periodic reversal of the current, which largely overcomes the last two difficulties. Alternating current, however, should avoid all the difficulties mentioned, and this has been found to be the case in experiments referred to in these notes.

Electrolysis by alternating current has been investigated by De la Rive in 1837[5] and later by Drechsel[6], Manoeuvrier and Chappius[7]. More recent work has been done by Baur[8], Shipley and Rogers[9], Remick and McCormick[10]. Present-day opinion seems to be that in order to obtain reasonable yields in alternating current electrolysis, it is essential to have an irreversible process, or at least one product which is insoluble. The author has now found[11] that this is not the case when the concentration of one product of the equilibrium is kept negligibly low as compared with the other. More specifically, in the case of hypochlorite in sea water, the oxidation product (active chlorine) is required in concentrations 10-3 to 10-4 times the salt concentration present. Under such conditions, yields of approximately 2 oz. of active chlorine per kWh can be obtained. The requirements for successful oxidation are sufficiently high current densities, and sufficiently small local concentration of oxidation products at the electrodes. Also, it is necessary to have electrodes which are not easily oxidised or reduced. Gold and platinum electrodes are well known for a.c. electrolysis, and the author has found that Mo-containing stainless-steels also show some promise for this purpose. Using such electrodes, aqueous solutions of acids and most inorganic salts will give hydrogen peroxide in the absence of halogens, and hypohalides in their presence. The yields are good initially, especially when the solutions are stirred and when thin wire is used for the electrodes. On further electrolysis, as the oxidation products achieve a higher concentration, the yields deteriorate rapidly. In running water, such as cooling-water in power stations, no stirring is required; the electrodes can be inserted parallel to the flow. In a preferred arrangement, the electrodes consist of thin platinum wire, coiled round an insulating sheet of glass or polystyrene. At a distance of $\frac{1}{2}$ in. between the electrodes and using 6-7 volts of 59-cycle a.c., a yield of 2 oz. available chlorine was obtained per kWh. The results were reproducible within a narrow range.

In a typical experiment, the rate of flow was 600 gal./hr., the current 6.6 amp, at 6.6 volts, the concentration at the outlet of the cell being 1 p.p.m. available chlorine. The cell consisted of a glass trough 6 in. wide and the water was 6 in. deep. The electrodes consisted of two strips of polystyrene $2\frac{1}{2}$ in. wide and 14 in. long. Pt-wire of 0.004 in. dia. was wound onto these strips at $\frac{1}{2}$ in. intervals. One side of the resulting coil was sealed-off with a waterproof styrene lacquer, exposing 27 lengths of $2\frac{1}{2}$ in. on each electrode. The total exposed area of each electrode was 5.5 sq. cm. and the current density 1.2 amp/sq. cm. The distance between the totally submerged electrodes was $\frac{1}{2}$ in. and the yield was calculated to be 2.2 oz. of active chlorine per kWh.

This yield is rather low when compared with 3-4 oz./kWh obtainable when d.c. is used[4] and with 11-12 oz./kWh[12], as obtained under factory conditions when concentrated brine solutions are electrolysed. Nevertheless, the process deserves serious consideration, even on a comparative cost basis where cheap power is available. In other instances it could still be worth while for reasons of greater safety and convenience. When comparing costs of the suggested method with other methods of chlorination, the following considerations will have a bearing on the result.

Maintenance costs should be considerably lower, as there are no concentrated chlorine solutions in contact with any part of the equipment. In this connection it must be pointed out that the effect of prolonged electrolysis on the electrodes has not yet been ascertained. When the electrode material is platinum, this must have a smooth surface, otherwise the yield will decrease. Platinum black completely stops the generation of chlorine at the electrode surface. Under the conditions of the experiments carried out, there was no evidence of attack on the electrodes.

The yields reported above were obtained in experiments using the electrodes as described, or electrodes of very similar construction. Such electrodes have two shortcomings which affect the yield adversely. Firstly, the insulating sheet onto which the wire is wound restricts the flow of water at the electrode surface. This impedes the fast removal of oxidised ions, from the vicinity of the electrode wire, prior to the wire's reversal of electric

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charge. Secondly, the arrangement allows a substantial number of oxidised ions to come into contact with wires further downstream, and half of these could be reduced on such contact. It is hoped that both difficulties will be overcome by the use of wires in a plane perpendicular to the flow. A considerable improvement in yield is expected.

The yield given has been calculated by multiplication of the throughput of water and the available chlorine, as determined by the O-Tolidine method. When reaching the sampling point, the water has been chlorinated for approximately 30 sec. During this time, and mainly in the vicinity of the electrodes, a considerable quantity of active chlorine could have reacted with some of the materials to be chlorinated, and thus escaped determination. This aspect could not be checked by variation of the current, as the active chlorine contents is not linearly proportional to the current.

The dosage required to achieve identical control of fouling could well be smaller than the calculated value, based on active chlorine contents. A higher residual chlorine content is said to be permissible, with more economical "slug" dosage when Hypochlorite is used (J. D. Springs)[13]. Lundborg, Lindhe and Levin[14] claim that electrolytic chlorine is more effective in the control of bacteria than an equivalent quantity of chlorine gas. If this is correct, the effect is probably due to other oxidising compounds produced, and direct action at the surface of the electrodes on the organisms.

Regulation of the dosage and automatic timing of chlorination is considerably easier when electrolytic cells are used, while several banks of electrodes can be installed at intervals in a cooling-water conduit and connected to separate transformers. These transformers may be switched on automatically with each circulating-water pump, ensuring the right proportion of chlorine to cooling-water. Furthermore, there are no freight and handling charges.

In locations where chlorine is expensive and power is abundant, such as power stations in remote areas, the method seems well worth further investigation. Even without consideration of any of the above points, simply lb. for lb. of active chlorine, a.c.-electrolysis costs are less than half of present costs of chlorine at such power stations.

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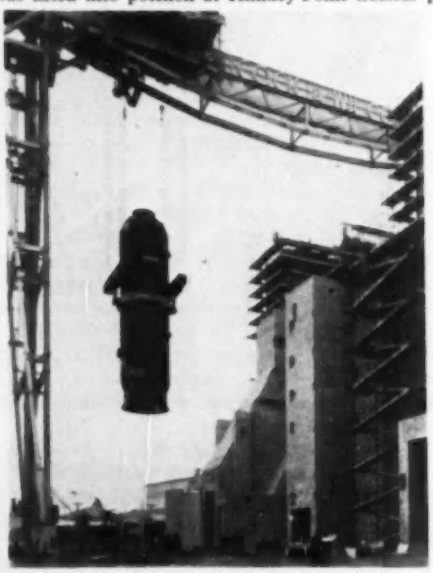
FIRST HINKLEY STEAM-RAISING UNIT

On January 12th the 385-ton steel shell of a steam-raising unit was lifted into position at Hinkley Point nuclear power station, near Bridgwater, Somerset. The lift was made by the 250-ft. high, 400-ton Goliath crane, moving on its own rails and straddling No. 1 reactor building, which is already more than 90 per cent. complete, and over 160-ft. high. This is the first of the twelve steam-raising units to be installed. They will provide the steam supply to the turbines of the 93.5-MW generating sets. Each steam-raising unit is 90-ft. long by 21-ft. 6-in. dia., and when equipped for operation will weigh over 1,200-tons. This lifting of the first steam-raising unit, took place approximately two years after the commencement of construction work at the site, where the 500-MW nuclear power station is being erected by the English Electric, Babcock & Wilcox, Taylor Woodrow Atomic Power Group for the C.E.G.B. It is anticipated that the first reactor will become critical towards the end of 1961, and that the station will be in commission during 1962. Fabrication in the workshops at the Hinkley site is proceeding on the second, third and fourth steam-raising units and also on the two 67-ft. dia. reactor pressure-vessels. The mechanical engineering phase of work is progressing rapidly, while the civil engineering work is approaching completion. Construction of the Hinkley turbine-house, which will be the largest in Europe, is, together with its associated buildings, also well advanced.



The 385-ton shell of the first of the twelve Babcock & Wilcox steam-raising units at Hinkley Point being lifted to its position alongside No.1 reactor building.

C.E.G.B. CONTRACTS

The Central Electricity Generating Board has placed contracts recently for power station, transmission lines and transforming stations amounting in the aggregate to approximately £13,020,000. The principal contracts include: West Thurrock power station, two 300-MW re-heat boilers, Nos. 3 and 4 (Babcock and Wilcox Limited); one 210-MVA, 275-kV generator transformer, No. 2 (C. A. Parsons and Co. Ltd.); Thorpe Marsh power station, two 310-MVA, 275-kV generator transformers (English Electric Co. Ltd.); Fleet-Alton/Portsmouth (extension), 275-kV double-circuit overhead line (Balfour Beatty and Co. Ltd.); Stafford-Rugeley, 275-kV double-circuit overhead line (Riley and Neate Limited).

POWER PLANT ENGINEERING

during 1959

DURING 1959 the Central Electricity Generating Board installed more than 2¼-million horsepower of new generating plant. The total additional electrical output of this new plant was 1,670-MW, which is some 516-MW up on the previous year's figure, but 127-MW less than the record figure (1,797-MW) in 1956. As shown in the accompanying table, this new plant was installed in fifteen power stations (five of them new stations, in which plant was commissioned for the first time) owned by the C.E.G.B. in England and Wales. The new installations consisted of twenty-one turbo-generators with an aggregate capacity of 1,775-MW and twenty-three boilers with a total evaporative capacity of 14,700,000-lb./hr. of steam. It will be noted that in addition to the plant listed in the table, three boilers were commissioned but made no contribution to output capacity because the associated turbo-generators have not yet been commissioned. For example, at Northfleet (Kent), a new station in which no plant has so far been commissioned, No. 1 boiler, a Foster Wheeler unit of 860,000 lb./hr. capacity, has been completed. At South Denes (Great Yarmouth) No. 4 boiler—a Mitchell Engineering Limited 550,000-lb./hr. unit has been commissioned. At Spondon "H"—a new station adjoining the existing 172-MW Spondon station (and designed primarily to supply 400,000/600,000-lb./hr. of steam to the adjoining factory of British Celanese Ltd., after it has been passed through three 10-MW back-pressure turbo-alternators), the fourth and last of the 180,000-lb./hr. boilers supplied by Foster Wheeler Limited, was completed but not put on the steam range. These four boilers operate at a pressure of 950-lb./sq. in. and a final temperature of 895 deg. F. Of the generating sets installed during the year the first of a number of 200-MW units planned for commissioning during the next few years was brought into service at High Marnham during October last. This set, the first of five such sets to be installed at High Marnham, is the largest unit yet installed by the Board, and it has a greater output capacity than any other unit operating in Western Europe. The associated unit re-heat boilers for these sets are being supplied by International Combustion Limited, and are of 1,400,000-lb./hr. capacity. Turbine stop valve steam conditions are 2,300-lb./sq. in. and 1,050 deg. F., with reheat to 1,000 deg. F. between the h.p. and l.p. cylinders.

It is planned to commission the first of four 275-MW machines at Blyth "B" power station in 1962, where the first two associated unit boilers, which are being supplied by Yarrow & Co. Ltd., are designed for an evaporative capacity of 1,950,000-lb./hr. at 2,400-lb./sq. in., and 1,055 deg. F. with reheat to the same temperature. Further ahead, is the new station at West Thurrock, the amended project for which provides for the installation of two 200-MW sets by C. A. Parsons & Co. Ltd., and steamed by Babcock & Wilcox unit boilers each of 1,350,000-lb./hr., and two 300-MW sets with two 2,050,000-lb./hr. boilers.

An important development during the year was the request by the C.E.G.B. to The English Electric Co. Ltd. to proceed with the design of the two largest single-shaft steam turbo-alternators yet to be built in Europe—viz., two 350-MW sets for the Board's new Drakelow "C"

STEAM GENERATING PLANT COMMISSIONED BY C.E.G.B. DURING 1959

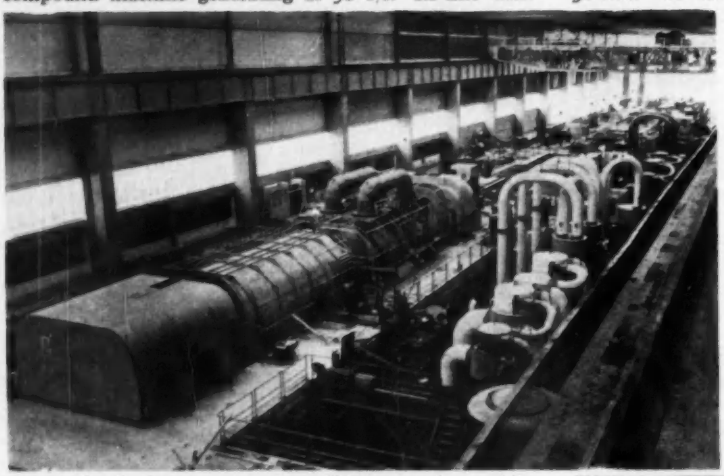
Name of Power Station	C.E.G.B. Project Group	Turbo-Generator Plant		Boiler Plant	
		Installed capacity (MW)	Maker	Capacity in lb./hr.	Maker
Steam Plant					
Agecroft "C"† ...	Northern	1 x 120	Associated Electrical Industries Ltd. ...	1 x 860,000	International Combustion Ltd.
Belvedere L.P.* ...	Southern	3 x 60	English Electric Co. Ltd.	3 x 550,000	John Brown Land Boilers Ltd.
Blyth "A"	Northern	2 x 120	Associated Electrical Industries Ltd. ...	2 x 860,000	Babcock & Wilcox Ltd.
Bold "B"	Northern	1 x 60	General Electric Co. Ltd.	1 x 550,000	John Thompson Ltd.
Castle Donington ...	Midlands	1 x 100	Associated Electrical Industries Ltd. ...	1 x 830,000	Babcock & Wilcox Ltd.
Drakelow "B"* ...	Midlands	2 x 120	C. A. Parsons & Co. Ltd.	2 x 860,000	Int.Comb.Ld./FosterWheelerLd.
Elland*	Northern	2 x 60	Associated Electrical Industries Ltd. ...	2 x 550,000	Yarrow/John Brown.
Ferrybridge "B" ...	Northern	1 x 100	C. A. Parsons & Co. Ltd.	1 x 760,000	Babcock & Wilcox Ltd.
High Marnham* ...	Midlands/Northern	1 x 200	English Electric Co. Ltd.	1 x 1,400,000	International Combustion Ltd.
Little Barford "B"* ...	Southern	2 x 60	C. A. Parsons & Co. Ltd.	2 x 550,000	Foster Wheeler Ltd.
Marchwood	Southern	1 x 60	English Electric Co. Ltd.	1 x 550,000	John Thompson Ltd.
Portishead "B"* ...	Southern	1 x 65	Associated Electrical Industries Ltd. ...	3 x 300,000	Mitchell Engineering Ltd.
South Denes	Southern	1 x 60	Richardsons Westgarth Ltd.	1 x 550,000	Mitchell Engineering Ltd.
Spondon "H"† ...	Midlands	1 x 10	Associated Electrical Industries Ltd. ...	1 x 180,000	Foster Wheeler Ltd.
Willington "A" ...	Midlands	1 x 100	English Electric Co. Ltd.	1 x 830,000	International Combustion Ltd.
15 Stations including 5 New Stations and 2 New Sections	3 Project Groups	21 Turbo-generators having an aggregate installed capacity of 1,775-MW		23 Boilers having an aggregate installed capacity of 14,700,000 lb./hr.	

In addition to the above, the following boilers have been completed but not commissioned, as the associated turbo-generators are not yet available:—Northfleet—Boiler No. 1—860,000 lb./hr. capacity, manufactured by Foster Wheeler Ltd. South Denes—Boiler No. 4—550,000 lb./hr. capacity, manufactured by Mitchell Engineering Ltd. Spondon "H"—Boiler No. 24—180,000 lb./hr. capacity, manufactured by Foster Wheeler Ltd., was completed but not put on the steam range.

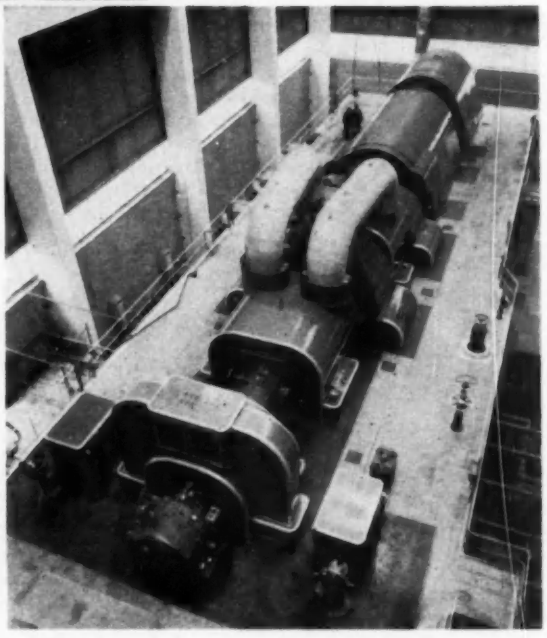
NOTES:—The Power Stations marked thus (*) are new stations in which plant has been commissioned for the first time in 1959, and those marked thus (†) are new sections. The remainder are existing stations to which extensions have been made.

power station near Burton-on-Trent, and which will have an ultimate installed capacity of 1,400/1,500-MW. The turbines will operate with inlet steam conditions of 2,300-lb./sq. in., and 1,050 deg. F. with reheat to the same temperature.

During the year it was announced by the Board that the second 550-MW machine for Thorpe Marsh power station is to be supplied by A.E.I. (Manchester) Limited. It will be the largest two-speed conventional cross-compound machine generating at 50 c/s. In line with recent developments, steam conditions at the turbine inlet will be 2,300-lb./sq. in., and 1,050 deg. F. with reheat also to 1,050 deg. F. The associated boiler unit which will have an evaporative capacity of 3,750,000-lb./hr. is to be supplied by Babcock & Wilcox Limited. The first 550-MW set for the station is, it will be remembered, being supplied by C. A. Parsons and Co. Ltd., and the associated boiler (also of 3,750,000-lb./hr. capacity) by International Combustion Limited.



(Left). The first of the five tandem 200-MW turbo-alternators which are being constructed for High Marnham by The English Electric Co. Ltd., shown installed in the station.



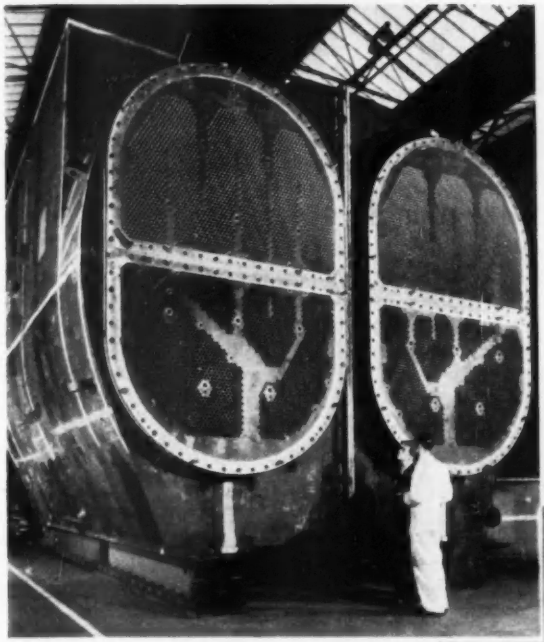
(Below). The second of four English Electric 100-MW turbo-alternator sets installed at Willington "A" power station. This machine is the first in Great Britain to incorporate direct hydrogen-cooling of both stator and rotor windings.

THE ENGLISH ELECTRIC CO. LTD.

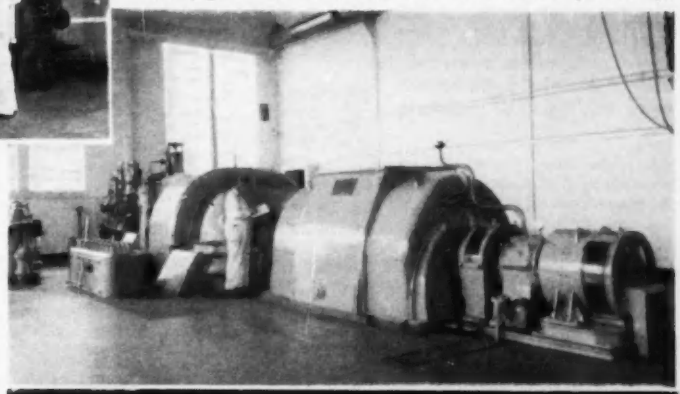
During 1959 The English Electric Co. Ltd. received an order from the Central Electricity Generating Board for two 350-MW turbo-alternator units for Drakelow "C" power station. These units, when installed, will be the largest single-line machines in Britain, the turbines being designed to run at 3,000 r.p.m., and operate at 2,300-lb./sq. in. and 1,050 deg. F., with reheat to 1,050 deg. F., and exhaust to 28.7 in. Hg. vacuum. The alternators will be of the fully-direct-cooled type, employing a water-cooled stator and a hydrogen-cooled rotor (with a rated gas pressure of 45-lb./sq. in.), generating at 19,500-V. A further contract received during the year from the C.E.G.B. was for a 120-MW unit for Bankside "B" power station. Running at 3,000 t.p.m., the turbine will operate at 1,500-lb./sq. in., and 1,000 deg. F., with reheat to 1,000 deg. F., and a vacuum of 28.9 in. Hg. The alternator will have direct hydrogen-cooling of the rotor, with a rated gas pressure of 30-lb./sq. in. and generation will be at 13,800-V. Also for the home market, a repeat order was received from Kodak Limited for a 5,000-kW passout set, with operating conditions of 640-lb./sq. in. and 750 deg. F. at the turbine stop valve. An important order received from overseas covered two 200-MW units for the Vales Point power station, Australia, the largest single-line units so far ordered for any power station in the Southern Hemisphere; the Vales Point station being designed for an ultimate capacity of 1,500-MW. The machines will run at 3,000 r.p.m., and operate at 2,350-lb./sq. in. and 1,050 deg. F., with reheat to 1,000 deg. F. and exhaust to 28.4 in. Hg. vacuum. The alternators are of the fully-direct-hydrogen-cooled type, generating at 16,500-V with a rated gas pressure of 30-lb./sq. in. Further orders from abroad include a 30-MW set for Hex River power station, Electricity Supply Commission, South Africa, and a 25-MW unit for Grand Pass power station, Government of Ceylon. The former will operate at 600-lb./sq. in. and 900 deg. F., with a vacuum of 28.2 in. Hg., and the latter at 900-lb./sq. in. and 900 deg. F., with a vacuum of 27.5 in. Hg. Generation in both cases will be at 11,000-V. Finally, an order for a second 10-MW set was received from the

Sudan Light and Power Company for their Burri power station.

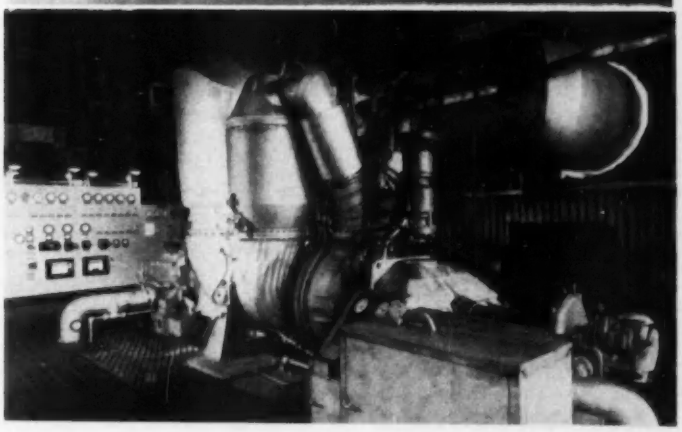
During the year the first 200-MW unit at the High Marnham station of the C.E.G.B. was put into operation, this being the first of five such machines for the station, designed to operate at the extra high steam pressure of 2,350-lb./sq. in. and 1,050 deg. F. with reheat to 1,050 deg. F., and a fully-direct-hydrogen-cooled alternator operating at a gas pressure of 30-lb./sq. in. The official opening of the Willington station of the C.E.G.B. also took place during the year, when the fourth 100-MW set was commissioned. Here, the No. 2 unit is of particular interest as representing the development in design of the "English Electric" fully-direct-cooled alternator. Commissioned in June, 1958, this prototype unit is reported to have given satisfactory and trouble-free running; while the Willington station itself was placed fourth in the Central Electricity Generating Board's list of twenty most efficient stations during 1958/9, in spite of a relatively low load factor. Amongst other sets commissioned for the C.E.G.B. during the period under review were two 60-MW units for Belvedere and the eighth and final 60-MW set for Marchwood. These turbines all operate with steam conditions of 900-lb./sq. in. and 900 deg. F. Overseas, a 66-MW, 3,600 r.p.m. set was commissioned at the Queen Elizabeth power station of the Saskatchewan Power Corporation, and a 45-MW, 3,600 r.p.m. set at the Water Street power station, Nova Scotia Light & Power Co. Ltd., Halifax. Other sets commissioned abroad were a fifth 30-MW set for Pretoria "B" (South Africa) and a third 30-MW set for Mercer power station, New Zealand. Among smaller units commissioned overseas were the second 10-MW set for Malacca, and the first of two 10-MW units for Penang.



(Above). The condenser for one of the 93.5-MW turbo-alternators for Hinkley Point nuclear power station, under construction at the English Electric works.



(Top, right). A 5,000-kW pass-out turbo-alternator set supplied by The English Electric Co. Ltd., to Kodak Limited.



(Bottom, right). An English Electric EM27 gas-turbine driving a direct-coupled centrifugal gas-compressor at the Fawley refinery of Esso Petroleum Co. Ltd.

Gas-turbines

Additional manufacturing facilities for the production of "English Electric" gas-turbines were made available during 1959, together with a permanent test area, fully-equipped for full-load testing of gas-turbines up to 8,000-kW rating. Here, at the present time, the first production EM85 gas-turbine is undergoing a comprehensive series of proving tests before despatch to site. This unit is the first of seven machines ordered by the Iraq and Basrah Petroleum Companies for pump drive applications in the Middle East. Production of the EM27 unit with a rating range of 2,300-3,000 b.h.p. has continued, and during the year turbines of this type have been shipped to Canada, Sarawak and Indonesia. A EM27 gas-turbine installed at the Esso Refinery, Fawley,

for driving a gas-compressor in the new petro-chemical plant, is the first British gas-turbine at a petro-chemical process unit to run continuously on a gaseous fuel. The machine has now been in commercial service for approximately twelve months, during which time it has operated for 8,000 hours at a high load factor. Service experience is reported to have been very satisfactory, and a very high availability has been achieved.

Work on the design, development and manufacture of special axial-flow blowers has also been undertaken by the company during the year, and at present orders include twelve single-stage carbon-dioxide circulators for Hinkley Point nuclear power station, and a number of multi-stage blowers for the cooling of large turbo-type alternators. Development continues on improved designs of blower for similar duties.

Transformers

An order for two 310-MVA 275-kV generator transformers, the largest type yet ordered for service in the British Isles, was received during the year. These are for the Thorpe Marsh station of the C.E.G.B., and will incorporate the recently developed "English Electric" high-speed resistor tap-changer, for which orders have also been received. This switch, capable of 500-kV neutral-end working, is of an entirely new design. A repeat order covering a 50-MVA 110-kV three-phase bank for New Zealand, has been placed, together with a 250-MVA, 154-kV three-phase bank for the U.S.A. The first of the five 210-MVA, 275-kV generator transformers for High Marnham power station was delivered during the year and is now in commission. Also installed were the 330-kV transformers at Kariba, ready for the commissioning of the first generators planned for early 1960.

Among new developments reported is a design for a transformer noise enclosure.

Nuclear power plant

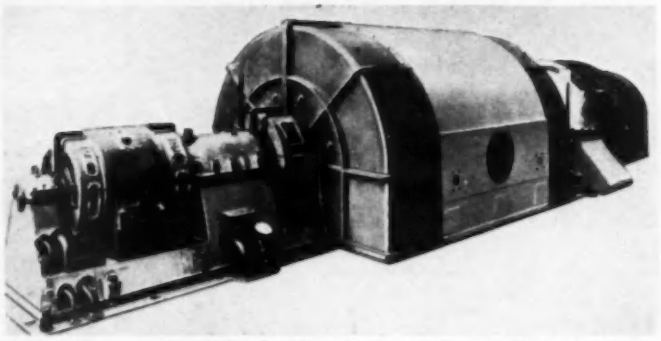
Work has continued on the construction of Hinkley Point nuclear power station for the Central Electricity Generating Board by the English Electric, Babcock & Wilcox, Taylor Woodrow Group. The civil works have now been substantially completed and the station is scheduled to come into operation towards the end of 1962. Babcock & Wilcox Limited are proceeding with the fabrication on site of the 67-ft. diameter, 3-in. thick steel spherical pressure vessels and the steam raising units. Manufacture of the high-voltage air-blast circuit-breakers and the turbo-alternator sets at the works of The English Electric Company is well advanced, and the first condenser has already been delivered. There are in all six main turbo-alternator sets, each developing 93.5-MW, and three variable-speed sets of 33-MW each to provide power for the gas blowers. The first of the twelve single-stage axial blowers of 7,000-h.p. capacity will be delivered to site in 1960. The squirrel-cage motors for the first blowers have been built and are now undergoing tests.

A large new workshop at Whetstone has been equipped with the latest automatic machine tools and material handling equipment for the machining of graphite moderator components for reactor cores. Production of the many thousands of graphite components for Hinkley Point started during 1959. Other extensions at the "English Electric" works now coming into use are shops for assembly, under rigorous conditions of cleanliness, of the heavy reactor fuelling machinery. A very specialised facility includes a test pit some 60-ft. deep enabling fuelling machinery to be tested under working conditions before being installed in the reactor.

An agreement between The English Electric Co. Ltd. and the Atomics International Division of North American Aviation Inc., in the field of organic liquid cooled and moderated reactors, was concluded during the year.

C. A. PARSONS & CO. LTD.

The most important order received by C. A. Parsons & Co. Ltd. during 1959 was for a 500-MW turbo-alternator set for the Tennessee Valley Authority of America, to be installed at Colbert, Alabama. The machine will be a cross-compound unit comprising two lines of turbines each driving a hydrogen- and liquid-cooled generator at a speed of 3,600 r.p.m. and operating with steam conditions of 2,400-lb./sq. in. and 1,050 deg. F., with reheat to 1,000 deg. F. The Tennessee Valley Authority have also ordered two 10,000-b.h.p. turbines for driving the boiler feedpumps at the same station. Other large machines ordered for power stations included four 200-MW and two 300-MW units for Canada and a 550-MW and two 200-MW units for installation in this country. A third 20-MW machine has been ordered by the Trinidad and Tobago Electricity Commission to be installed in the Penal power station; the first Parsons 20-MW set in that power station was officially put into commission by the Governor of Trinidad and Tobago, His Excellency Sir Edward Betham Beetham, in February, 1958.



One of the three 20-MW turbo-alternator sets being provided by C. A. Parsons & Co. Ltd. for the Trinidad & Tobago Electricity Commission, Penal power station.

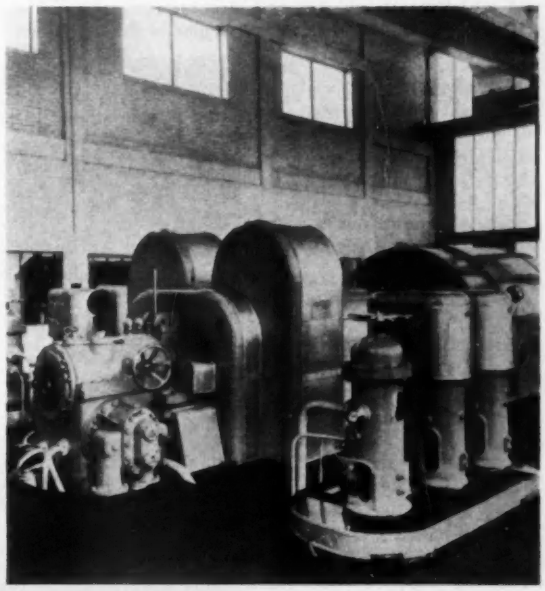
Turbo-alternator sets completed in 1959 included two 120-MW sets at Drakelow "B" and one at Kincardine; the third 100-MW set at Ferrybridge "B" and the first of six 100-MW machines at Aberthaw; and 60-MW sets at Little Barford "B." In addition, a 15-MW set was completed at the Thames Mill of Bowaters Paper Corporation; this machine being a back-pressure set operating with steam at 900 lb./sq. in. and 900 deg. F.

Overseas, the first 200-MW set to be constructed in

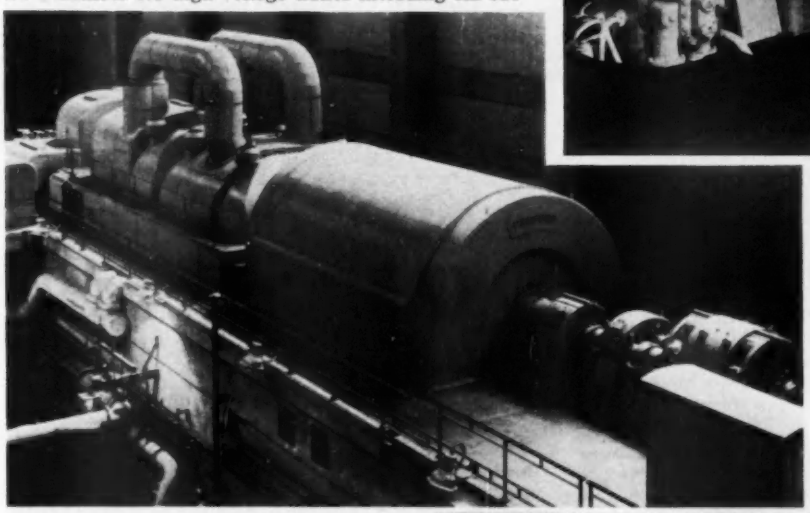
this country was put into operation in the Richard L. Hearn generating station of the Hydro Electric Power Commission of Ontario, and a second set was completed during the year. Further machines installed in Canada included the first of two 66-MW sets in the Boundary Dam station, a 20-MW set at Trenton, Nova Scotia, and an 18.75-MW set for the Dominion Steel and Coal Corporation, Seaboard power station. In Australia, the second 60-MW turbo-alternator was completed in the Wangi power station (Lake Macquarie) and machines of 30-MW output at Bulimba "B," Tennyson, Bunbury and Melbourne, and the first of two 15-MW sets at Muswellbrook power station, N.S.W. A 30-MW set has also been put into commission in the Colenso power station, South Africa, and the first of two machines of similar output in the Ijora "B" power station, Nigeria. Other machines of 20-MW and 15-MW output have been completed in India and Jamaica.

Transformers

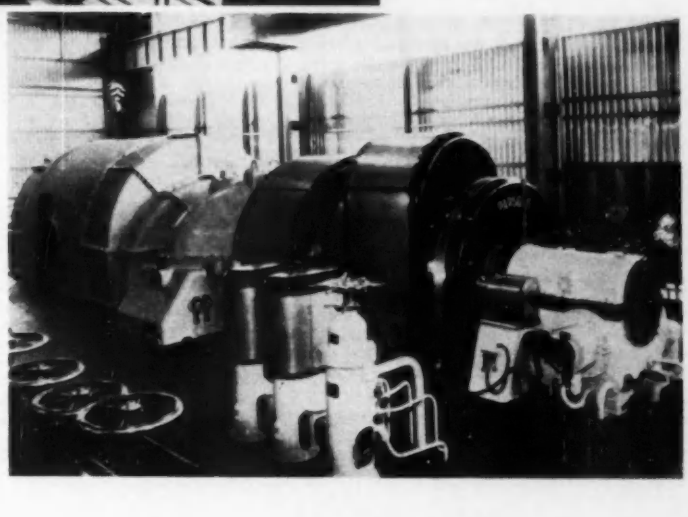
Among the orders received during the year from the Central Electricity Generating Board for transformers are a number for high-voltage duties including six 120-MVA 275/66-kV, ON/OFB units for various sub-stations; a second 210-MVA 16.5/295-kV OFW generator transformer for West Thurrock power station; and a number of 132-kV units ranging from 15-MVA to 45-MVA.



(Above). Among smaller machines supplied by C. A. Parsons & Co. Ltd., was a 10-MW turbo-alternator set installed in the power station of the Shell Refining Co. Ltd., at Shellhaven.



(Above). One of the two 120-MW turbo-alternator sets supplied by C. A. Parsons & Co. Ltd., for the Drakelow "B" power station of the Central Electricity Generating Board.

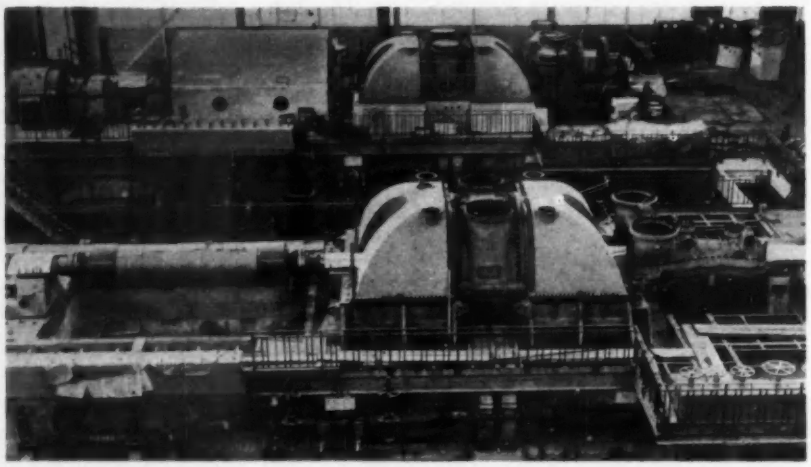


(Right). Overseas orders completed during the year by C. A. Parsons & Co. Ltd., included the first of two 15-MW turbo-alternator sets for Muswellbrook power station, N.S.W., Australia.

In addition orders were received for 66-kV transformers in the range 10-MVA to 25-MVA. A further order has been received from Venezuela for a 50-MVA transformer 66/30-kV, making the fourth transformer of this size and type to be supplied to this customer. The transformers have off-load tappings and air-blast cooling.

Nuclear power plant

During the period under review the last of the eight 23-MW machines at Calder Hall was put into commission, and at Chapelcross seven machines of similar output were commissioned. Work is proceeding on the turbo-alternators to be installed at Bradwell nuclear power station, and to date four machines have been completed at the company's works and erection is proceeding on site.



A recent view in the turbine house at Bradwell, showing the state of completion of the first two turbo-alternator sets. C. A. Parsons & Co. Ltd. are supplying six machines for this station, each rated at 52-MW.

Work is proceeding in the company's Heaton Works on a number of high-voltage transformers, including a 210-MVA 16.5/295-kV OFW generator transformer and two 40-MVA 275/11.6-kV ON/OFB station transformers for West Thurrock power station, and two 180-MVA 132/275-kV ON/OFB auto-transformers for Keadby power station. Work is well advanced on the first of seven 50-MVA 12.5/330-kV OFW single-phase generator transformers ordered for the extensive scheme now being carried out by the Snowy Mountains Hydro Electric Authority, Australia.

The company are supplying altogether six main turbo-alternator sets, each rated at 52-MW, together with three 20.25-MW auxiliary machines for the Bradwell station. In addition, it will be remembered that their contract includes the supply of all condensing plant, dump condensers, main gas-circulators, gas ducting and valves, the charge-tube assemblies and control-rod assemblies, fission product detection compressors and the instrumentation, including the start-up equipment.

Sir David Eccles, Minister of Education, has appointed **Sir Harold Roxbee Cox,** Ph.D., D.I.C., D.Sc., M.I.Mech.E., F.R.Ae.S., F.Inst.F., F.I.Ae.S., as chairman of the National Council for Technological Awards, in succession to **Lord Hives,** who has retired. Sir Harold has been vice-chairman of the National Council since its establishment in 1955. Sir Harold Roxbee Cox, formerly chief scientist, Ministry of Fuel and Power, is deputy-chairman and chairman-elect of the Metal Box Co. Ltd., and a director of Wilmot Breeden (Holdings) Limited, and of Boulton Paul Aircraft Limited. He is also a vice-chairman of the Council of the Air Registration Board, vice-chairman of the Governors of the College of Aeronautics, and a member of the Council for Scientific and Industrial Research.

* * *

Three Cantor Lectures on " The Fuel and Power Industries and National Prosperity " will be delivered by **Dr. A. Parker,** C.B.E., D.Sc., F.R.I.C., M.I.Chem.E., lately Director of Fuel Research, D.S.I.R., at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2, on Mondays, February 15th, 22nd and 29th, 1960, at 6 p.m. The lectures will be illustrated by lantern slides. The respective titles of the three lectures will be World and National Energy Resources, Production and Treatment of Coals and Oils, and Natural and Manufactured Gas. Applications for tickets should be addressed to the Secretary of the Society, at the above address.

* * *

Mr. J. B. Laurie, B.Sc. (Eng.), M.I.E.E., has taken up the new appointment of general manager (Commercial) at the Production Group Headquarters, of the United Kingdom Atomic Energy Authority, Risley. He will be particularly concerned with the negotiation of contracts for the sale of uranium fuel elements for home and overseas reactors and associated " know-how " agreements.

* * *

The contract for the high-lift pumping plant to be supplied for the extensions to the Riverton pumping station of the Municipality of Kimberley, has recently been awarded on the recommendation of the municipality's consulting engineers, Campbell, Bernstein and Irving, Durban, South Africa, to **W. H. Allen Sons & Co. Ltd.,** Queens Engineering Works, Bedford, through their agents, Dowson & Dobson Limited, of Johannesburg. The plant comprises an 18-in./16-in. horizontal-spindle, three-stage, double-suction series pump driven by a 1,250-h.p. electric motor, together with switchgear, valves and pipework. The existing pumps at the Riverton pumping station are also of W. H. Allen manufacture.

* * *

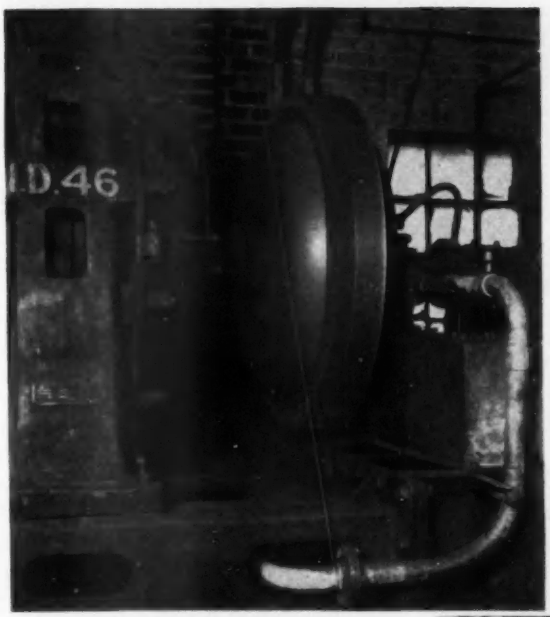
" The Case-Hardening of Nickel Alloy Steels," is the title of a publication issued recently by **The Mond Nickel Co. Ltd.** The publication explains, with the assistance of numerous tables and diagrams, the object of case-hardening steel components, and the three processes employed—pack carburising, gas carburising and liquid carburising. The heat-treatment after carburising is also dealt with in detail. The publication also includes information on core properties, fatique and carburising defects and their elimination. An appendix provides full information on the influence of temperature and time of carburising on case depth which will be valued by those engaged in the heat-treatment of steels. This publication may be obtained free on request from The Mond Nickel Co. Ltd., Publicity Department, Thames House, Millbank, London, S.W.1.

Thirty Years of Fluidrive

TO mark the completion on January 1st, of thirty years' existence and progress, Fluidrive Engineering Co. Ltd. have published a general brochure describing the various types of Vulcan-Sinclair fluid couplings, and the reasons why they are used throughout industry.

The principle of the fluid coupling was discovered by Dr. Hermann Fottinger in 1905, the patent No. 238804 being taken out in the name of the Vulcan Company of Stettin. Dr. Fottinger also patented the Transformator, or torque converter, and this was developed energetically as a means of transmitting power from steam turbines to ships' propellers. The development of the fluid coupling, however, was neglected for about fifteen years. After World War I, the Vulcan Company, having abandoned the torque converter because of its relatively low efficiency, turned its attention to the fluid coupling, and developed it for ship propulsion. Nevertheless, in spite of their considerable success in the marine field, it was thought at the time that there was no case for the fluid coupling in industry, and it was in England, due to the joint energies of Mr. Harold Sinclair and Mr. Antony Vickers, that fluid couplings were developed for road and rail vehicles, and for industrial drives. In October, 1928, Mr. Sinclair, in conjunction with Mr. Vickers, founded Hydraulic Coupling Co. Ltd. (later called Hydraulic Coupling Patents Limited), and more recently Fluidrive Patents Limited. The new company then reached an agreement with Deschimag—the German concern that had taken over the original Vulcan Company —by which the coupling designs evolved by Mr. Sinclair were to be known as Vulcan-Sinclair fluid couplings, while Hydraulic Coupling Patents Limited placed its patents at the disposal of Deschimag for marine propulsion applications. All other applications became the province of H.C.P. The first major development was the formation of Hydraulic Coupling and Engineering Co. Ltd., later renamed Fluidrive Engineering Co. Ltd., which was started up at Isleworth in January, 1930, with a small but enthusiastic team devoted to the design, development and manufacture of Vulcan-Sinclair fluid couplings. The licence from H.C.P. included the industrial rights in Great Britain, other licences being granted later to leading engineering concerns in the United States, Germany, France and Italy; also to The Daimler Company, and to Associated Equipment Company in connection with motor cars and buses.

The first infinitely variable speed fluid coupling to drive a Sirocco induced-draught fan was installed in 1930 in Liverpool and was the forerunner of more than 6,000 for driving fans in power stations all over the world. In the following year, having shown a highly satisfactory way of providing speed regulation for fans, the first fluid coupling to drive a boiler feed pump went into service at Greenwich power station. Here again, a practice was commenced in boiler feed pump control, which was taken up strongly in the United States by American Blower Corporation, the industrial co-licensees



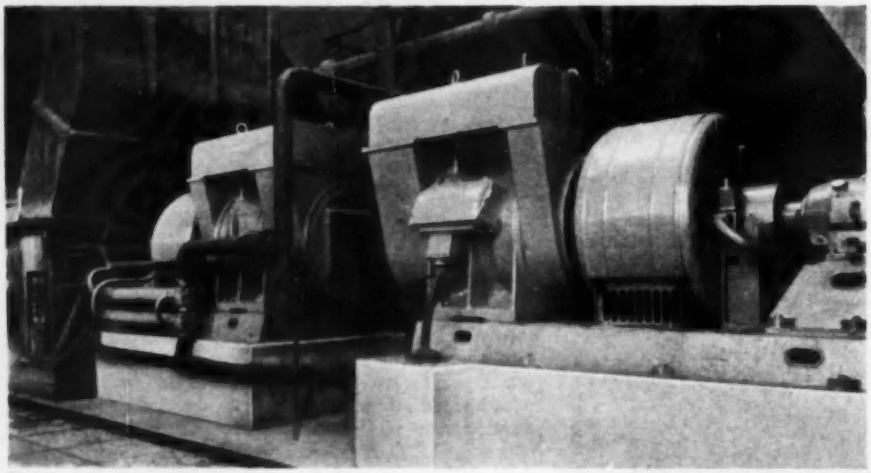
(Above). The first Fluidrive i.d. fan, installed at Lister Drive Power Station, Liverpool, in 1930.

(Right). One of six 3,000 h.p. boiler feed pump sets made by G. & J. Weir Limited, with size 20 D.S.T. Fluidrive, for the Hydro-Electric Power Commission of Ontario's Richard L. Hearn generating station.

in that country. Thus, during the last ten years, more than half the boiler feed pumps installed in the U.S.A. are driven by fluid couplings, and considerable numbers—in powers up to 8,000 h.p. and above—are being built at Isleworth and Bracknell. Similarly, in coal-handling plant, Fluidrive has been widely standardised for many years.

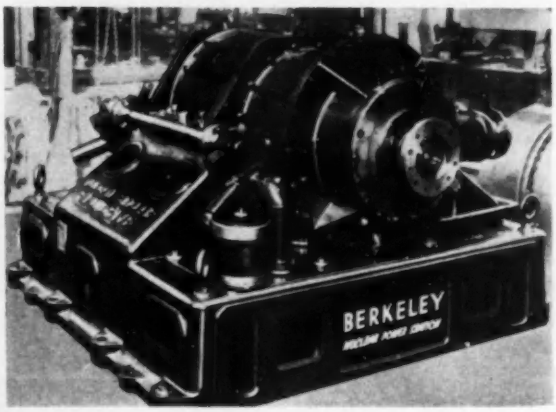
The motor car field was of special interest, and a revolutionary success was achieved in May, 1930, when The Daimler Company, using a Vulcan-Sinclair coupling with a Wilson planetary gear, introduced the first standard car fitted with fluid flywheel transmission. Shortly afterwards, this type of transmission was adopted for city buses by Daimler and A.E.C. and, later, by Leyland. At present, in London alone, there are some 9,000 Fluidrive buses. In the United States, the Chrysler Corporation exhibited their first Custom Imperial with Fluidrive in 1938, and subsequently made $3\frac{3}{4}$-million fluid couplings under Vulcan-Sinclair patents.

It is perhaps difficult to realise the extent to which Fluidrive is serving industry today. For example, in the steam power generating industry, some of the more important drives include those for wagon-tipplers, coal and ash-handling conveyors, coal crushers, i.d. and f.d. fans, re-circulating fans, pulverised-fuel mills,

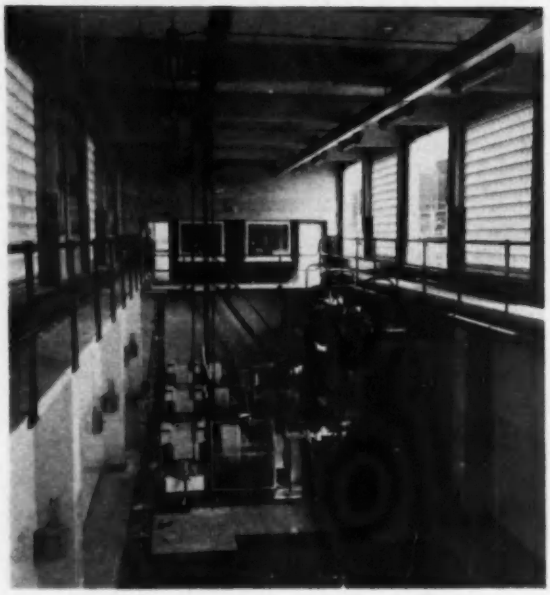


(Left). I.D. fan drives with S.C. motors of 479 h.p. at 740 r.p.m. and size 41 Vulcan-Sinclair scoop-control fluid couplings at the Stella South Power Station of the C.E.G.B.

(Right). One of sixteen size 22-25 D.S.T.s for driving CO_2 gas circulators at Berkeley Nuclear Power Station.



(Below). Interior of new West End pump house at Thames Haven, of London and Thames Haven Oil Wharves Limited, showing three Hayward Tyler pumps driven through Vulcan-Sinclair fluid couplings.



exhauster-fans, and boiler feed pumps. Fluidrive has an equally wide application in the mining industry, the gas industry, the oil industry, the iron and steel industries, and, more recently, in the nuclear power industry for the drives for gas-circulating fans, centrifugal pumps, transfer cars, door drives, elevators, etc.

A main purpose of the new brochure is to give the reader a general idea of the principal types of Vulcan-Sinclair fluid couplings and the reasons for their use, rather than complete information and application data, for which other literature is available on request to the company. Nevertheless, the brochure does include some comprehensive notes on the principle of Fluidrive, and on the various types of fluid couplings made by the

company. As will be appreciated, thirty years of experience in fluid mechanical power transmission, involving powers ranging from 1/10 h.p. to 10,000 h.p. has resulted in the development of the wide range of different types for various purposes. Space does not permit us to deal here with this wide range of couplings, but in industry generally, and in power stations with a base load or a fluctuating load, it has long been established that the combination of simple squirrel-cage motor and scoop-control fluid coupling provides the simplest and most robust equipment, together with the excellence of control, either automatic or otherwise, that is so essential for the most economical operating conditions. With the increasing trend to large boiler units, it is of interest to note that scoop-control fluid couplings have been selected for driving the mechanical draught fans of the 1.8 million lb./hr. boilers for the Lakeview Steam Station of the Ontario Hydro-Electric Power Commission, Canada, where the i.d. fans require 1,670 h.p. at 707 r.p.m. and the f.d. units 830 h.p. at 702 r.p.m. Perhaps the greatest virtue of the combination of S.C. motor and Fluidrive is in trouble-free operation, in which connection it is significant that the original fluid coupling is still in service. The high inertia of fans used for handling the huge volumes of air and gas demanded by large boiler units necessitates the use of costly motors of special design to accelerate the fans from rest. By using a scoop-control fluid coupling, a standard squirrel-cage motor can easily accelerate the fan and regulate its output as well, at a total capital cost that may be lower than that of a direct-coupled constant-speed motor.

As regards other applications, the field of established applications of SCR. 4 and SCR. 5 types of coupling is extremely wide, and this is steadily increasing with the greater adoption of automatic controls. Thus, with electric motor drives, centrifugal pumps, ball-mills, rotary driers, haulages and heavy conveyors are some of the principal uses, whereas with internal combustion engines, this type of fluid coupling is extensively used in locomotives, oil-drilling rigs and for marine propulsion. Certainly it is true to say that a tremendous variety of power transmitting duties has to be catered for in successfully applying Fluidrive, and hence much engineering design and development has been carried out in establishing the different types of Vulcan-Sinclair fluid coupling. Post-war expansion has been remarkable, and the company's output in 1959 was about ten times greater than it was in 1947 ; hence the need to build a new works at Bracknell, Berkshire, and to extend the facilities at the Isleworth works in order to keep pace with the growing demand.

Behind the company lies thirty years of experience in Vulcan-Sinclair fluid couplings in industry throughout the world, yet much is still being learned about fluid couplings, and put into practice for the more efficient and satisfactory application and control of mechanical power. The scoop-control fluid coupling, of which there are several varieties, also the SCD type, embodies this thirty years of experience with fluid couplings, the filling and emptying of whose working circuits is varied when running. The ability to vary the filling, whether slowly or rapidly, not only provides infinitely variable speed regulation, but also provides connection and disconnection of the drive. These two characteristics have resulted in the world-wide use of scoop-control fluid couplings, both with constant-speed electric motors,

(Left). Test bed at Fluidrive Works, Isleworth, where all development work is carried out.

(Below). Part of turret and capstan section in Bay No. 5 at Fluidrive Works at Bracknell.

and with internal combustion engines. Three features that are common to all varieties of scoop-control fluid coupling are the rotating reservoir casing, the sliding scoop which determines the amount of oil in the working circuit, and the absence of any gland. The basic principle of transmitting power from the impeller to the runner also applies to all types of Vulcan-Sinclair fluid coupling.

The ST type of fluid coupling represents another variety for infinitely variable speed regulation where rotational speeds of 3,000 r.p.m. and more are involved, as in the case of boiler feed pumps, crude oil and process pumps, turbo-compressors, gas-boosters, CO_2 blowers and such-like. The principles of power transmission through the vortex ring of oil remain the same, but the scoop-trim fluid coupling has certain special features for high-speed service. The principal difference from the scoop-control coupling is that the rotating reservoir is replaced by a scoop chamber of smaller diameter to keep down the peripheral stress, and an oil-tank is provided under the manifold bracket, with a circulating pump therein to maintain a constant flow through the working circuit of the coupling, via an oil cooler.

As the sizes of boilers and generating units increase, and feed pumps require 15,000 h.p. and more, it was logical to design the scoop-trim type of fluid coupling with two working circuits, the two scoop tubes being 'ganged together.' The main features of the DST design ranging in power from 1,500 h.p. to 20,000 h.p. at 3,000/3,600 r.p.m. are—(*a*) as the full power is transmitted through two circuits, each circuit transmits only half the power and, for a given diameter and speed, the efficiency will be higher.; (*b*) the two runners are bolted back-to-back, thus eliminating any internal thrust; (*c*) both the input and output shafts are fully-supported in bearings, and a continuously running centrifugal pump is driven through gearing from the former. In addition, an electrically-driven standby pump, used also when starting up, is provided. Fully flexible couplings of the gear tooth type connect the motor shaft to the fluid coupling and the fluid coupling to the driven machine, much study in the design stage having been given to ensure ease of installation and alignment with the driving and driven machines.

In the United States, where half the boiler feed pumps installed in power stations during the last ten years are driven by Vulcan-Sincalir fluid couplings made under licence by American-Standard Industrial, the overall saving in power and avoidance of excess pump pressure is an important economy. In many cases, feed-regulating valves are either eliminated completely, thus reducing capital cost, or are operated in the 'wide-open' condition, except when starting up, thereby reducing the cost of both operation and maintenance.

As we have mentioned earlier in these notes, Vulcan-Sinclair Fluidrive was originally made at Isleworth, but as each year the works were extended to meet increasing demand, the time came in 1950-1951 when an entirely new works was built at Bracknell. These works are equipped with the most modern machine tools, and operate in close collaboration with the works at Isleworth. Both works are equipped with a wide range of general machine tools, welding equipment and mechanical and hydraulic presses, and any particular form of production is carried out by the works most suited. To this extent, the more special types of coupling may be made initially at Isleworth where the design office and main test-bed plant are located. The total personnel of the company is just over 700, and great importance is attached to long service in whatever capacity, as is testified by what is known as the "Over 21 Club." Likewise, much importance is attached to the right selection and training of apprentices for the numerous different jobs of the future in the offices and works.

OVERSEAS WORK BY BRITISH CONSULTANTS

The Association of Consulting Engineers has issued its annual brochure listing the work being undertaken by British consulting engineers in the 60 or 70 countries in which they are engaged overseas. All forms of engineering are covered, from airports to roads and railways, and from thermal power stations to sea outfall sewers. Work being done by members of the association on the construction of new harbours, extensions to existing docks, port reclamation, provision of new berths, and associated equipment including dredgers, amounted during last year to no less than £70 million. Even greater was the volume of work in respect of hydroelectric projects: here the value of work under construction was £125 million. A second section of the brochure is devoted to schemes that are still in the preliminary stages of investigation and report. These projects include the Volta River works for producing aluminium, the nuclear power station for the Societa Ellettro-Nucleare Nazionale of Italy, the Northumberland Straits road/rail sea crossing and the Peace River development in Canada, and many more besides. Copies of the brochure can be obtained from the association, whose address, is Abbey House, 2, Victoria Street, London, S.W.1.

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FUEL EFFICIENCY AND POWER FOR INDUSTRY EXHIBITION

The scope of this now well-known exhibition (previously the Industrial Fuel Efficiency Exhibition), which is to be held at Olympia, London, from Wednesday, April 27th until Friday, May 6th, 1960, has been considerably increased, and is being arranged to offer the industrialist and all who are engaged in the production and provision of heat, light and power for industry, the opportunity to examine the latest methods of producing efficient services at the lowest cost.

WORK RESUMED AT HUNTERSTON

The dispute at Hunterston nuclear power station, Ayrshire, has now been settled. After a 15-week stoppage, the Motherwell Bridge & Engineering Co. Ltd., on January 11th, resumed operations on its £8 million contract for building the reactor spheres and steam-raising vessels at Hunterston nuclear power station. The company had suspended operations because of persistent unofficial strikes. Last month it offered a new wage structure and this was accepted by five of the six unions involved. The remaining union, the Boilermakers' Society, finally agreed to accept the terms on January 9th. The station, where 1,400 men engaged on other contracts remained at work during the dispute, is being built for the South of Scotland Electricity Board at a cost of £40 million. As a result of the unofficial strikes and the 15-week stoppage, it is now more than a year behind schedule.

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DR3 RESEARCH REACTOR, DENMARK

We learn that the nuclear research reactor DR3, supplied by Head Wrightson Processes Limited, 24/26, Baltic Street, London, E.C.1, for the Danish Atomic Energy Commission, became critical on January 17th. This reactor, which is installed at the Danish atomic research centre at Risö, near Copenhagen, is of the same family as "Pluto" at the United Kingdom Atomic Energy Research Establishment, Harwell, Like "Pluto," the DR3 reactor has a thermal output of 10-MW and a maximum neutron flux of 10^{14}n per square centimetere per second, and will be used for research into the effects of irradiation on materials. The fuel consists of stacks of dished plates of uranium/aluminium alloy clad in aluminium. The reflector is graphite and the moderator and coolant, heavy water.

Grit and Dust Sampling Equipment

SEVERAL items of equipment for the sampling of boiler flue gases and for the measurement of the grit and dust content of those gases are now generally available; it is, however, a feature of all known dust-sampling methods, whether they incorporate very small cyclonic devices, fabric filter pads, or a combination of both, or of apparatus based on thermal or anti-static re-action, that very small quantities of gas, hence ineffectual quantities of grit alone, can be investigated.

A method of sampling has been developed by Mancuna Engineering Limited, Denton, Manchester, for the investigation of both process and nuisance dust problems, employing in the apparatus a standard, very high-efficiency, miniature cyclone tube together with a textile sleeve filter providing for a minimum sampling gas volume of 84 cu. ft./min. with the possibility of operating the sampling device over a normal period of at least 30 min. Interest in this equipment for the investigation of grit and dust emission from boiler plant in particular, and the stated view of users and interested parties that this equipment is so far as is known "the only satisfactory dry sampling device available," has led to the recent development of a self-contained boiler grit-sampling device as illustrated in Fig. 1.

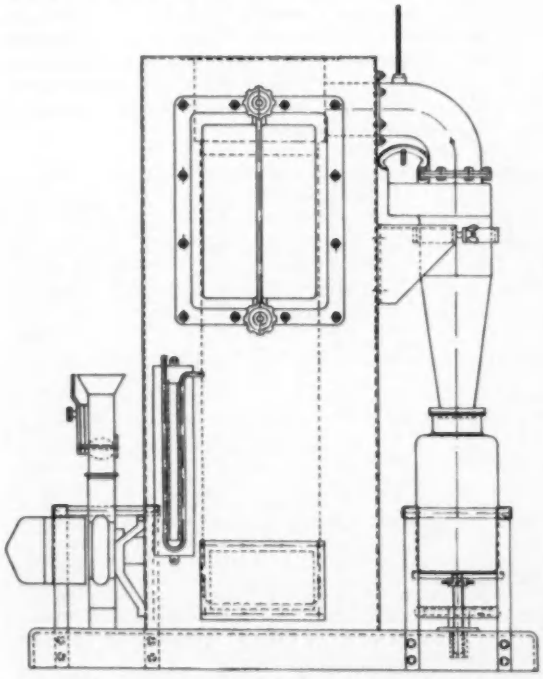


Fig. 1. Outline arrangement of the self-contained boiler grit-sampling device designed by Mancuna Engineering Limited.

The particular advantage of this equipment is that a gas volume that can be handled, hence the considerable sample by weight of grit and dust which can be collected over an extended period and providing for the minimum of sampling error; this is important where sampling devices handling, say, a maximum of 5 cu. ft./min., are employed. The device in question incorporates a standard miniature cyclone as used in the D.584 Mancuna-Dustex high-efficiency grit-arrester, and it will be of interest to potential users to recognise that the use of this tube, and the method of testing which is dependent upon the determination of the efficiency of the single tube, will provide an accurate forecast of the efficiency of any subsequent grit-arrester of this type, in addition to providing accurate information as to the nature, and grain loading of any grit and dust emission being experienced.

It will be appreciated that as with small-scale sampling apparatus, it is of extreme importance that a suitable sampling point should be available in the flue, duct, or stack, and ideally the sampling point should be available in a straight duct at a minimum distance of 10 diameters downstream from the nearest bend. There has been considerable controversy amongst specialised research workers as to the significance of accurate positioning of probes according to gas-flow characteristics, and it has been of particular interest recently to learn of at least one opinion that one, or at most three, sampling points are normally adequate, providing a common-sense appreciation based on a pilot traverse of the duct is made. This is very largely the experience of Mancuna Engineering Limited, in several hundred dust-sampling tests made with sampling equipment which is basically the same as that which is incorporated in the Mancuna grit-sampling device. It is considered that there are very few boiler installations where accurate readings cannot be obtained providing always, as previously stated, that an appropriate position for the probe relative to gas-flow is sensibly determined.

One important feature in the use both of the sampling device and of the Mancuna full-scale D.584 grit-arresting equipment is, that the efficiency of this equipment is so high that a considerable proportion of emitted soot is recovered, as well as grit and dust.

While in the full-scale grit-arrester this tends to reduce the blackness of smoke, it should be appreciated, in particular with reference to the sampling device, that the retention of soot both in sampling bottle and in the filter bag can influence the apparent efficiency of the cyclone cube. It will be readily understood that where a considerable quantity of soot is retained within the filter bag, its weight will have the effect of reducing the apparent over-all efficiency of the cyclone tube, even though the efficiency of the latter may be very nearly 100 per cent. on the actual grit and dust content of the effluent gases from the boiler.

The Mancuna grit-sampling device comprises a single D.584 Mancuna-Dustex cyclone tube, cast from an aluminium alloy, the main filter bag casing and associated baseplate also being of welded aluminium construction in order to minimise weight. The cyclone is clamped to the side of the textile filter casing, a glass bottle being fitted to the cyclone dust outlet, and held in position by means of an adjustable table manoeuvred by means of a hand screw. The clean gas outlet at the top of the

cyclone is flanged, and is fitted with a bend connected into the side of the textile filter casing, the latter being fitted internally with a suitable filter sleeve, and an aluminium access door to allow for removal of the sleeve.

The baseplate is extended to carry a portable exhaust fan, the inlet of which has a bayonet fitting to allow for quick coupling to a flange on the side of the main casing.

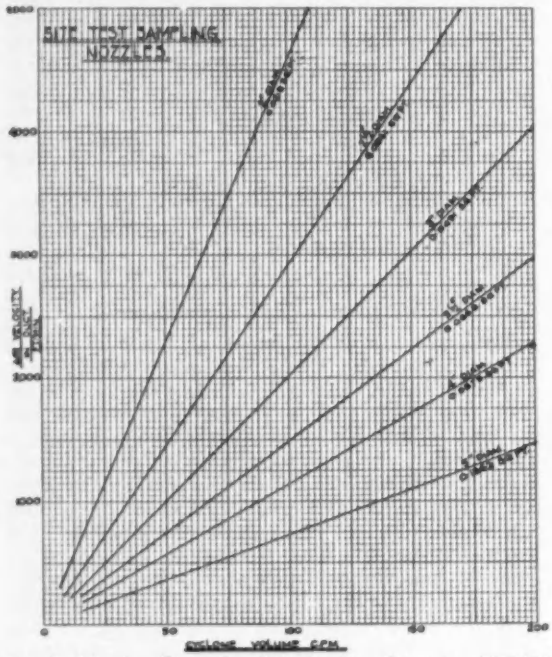


Fig. 2 (above). Graph for determination of nozzle diameter as against gas sampling volume.

Fig. 3 (right). Graph for determination of the pressure drop across the cyclone, against the operating temperature and gas sampling volume.

The fan outlet is fitted with a short exhaust duct having a locking butterfly damper for controlling the gas volume drawn through the unit. Provision is made below the access door for the fitting of a water manometer which is required to be connected by rubber tubing to pressure tapping points on the inlet and outlet of the cyclone. This manometer, together with a thermometer for which a suitable point is also provided, provides for a determination of gas volume drawn through the unit. Instruments can be supplied as an extra where necessary. In addition to the main assembly, sampling nozzles, a metal probe, together with a length of flexible metal hose for attachment to the cyclone inlet, are provided.

The fan can be supplied suitable for the following electrical supplies, the fan motor being rated at 1.75 h.p.

200-250 volts a.c. 40-60 c/s single-phase
100-130 " " 40-60 " " "
200-250 " d.c.
100-130 " "

The functions of the sampling device are two-fold:—

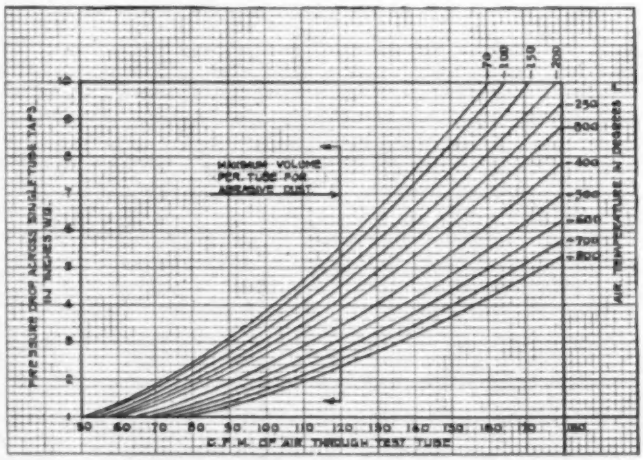
(a) To determine the collection efficiency of the D.584 cyclone tube fitted to the unit. This cyclone is identical to those fitted in D.584 grit arresters, thus the performance of a full-scale grit arrester can be forecast.

(b) To determine the grit and dust content of flue gases. From a determination of the collection efficiency of the cyclone tube, the grit and dust content in the flue gases can be measured at any time merely by the weighing of the amount of grit collected in the bottle under the cyclone tube over a given period, and by relating this weight of collected material to a simple formula or graph. In addition, an adequate truly representative sample of collected material is available for examination and analysis.

This latter procedure presupposes, of course, that the plant operating conditions remain unaltered. Where major alterations in operating conditions are effected (e.g., a change in fuel being used, or extensive change in load), then a re-assessment of the efficiency of the cyclone tube would be required under those new conditions. Normally, however, after an initial determination of cyclone tube efficiency, the measurement of the grit content of flue gases is a very simple matter which can easily be undertaken by the boiler operator after a minimum of instruction.

The recommended operating instructions for the Mancuna grit-sampling device are as follows:—

(1) After choosing a suitable sampling point, which, as previously mentioned, should be somewhere in a straight run of flue, duct or stack approximately 10 diameters downstream from the nearest bend, a hole 4½ in. dia. should be cut in the duct and a covering cap provided.



(2) The temperature of the flue gases should be measured at the sampling point.

(3) A pitot tube reading should be taken at the centre of the duct or flue, and the total volume and average velocity calculated. [The average velocity is 90 per cent. of the centre velocity under the conditions as in (1) above]. Where rectangular ducts or flues are involved, or the sampling conditions as in (1) above are impossible due to bends, valves, etc.,

then pitot readings should be taken as indicated in B.S.S. 1042 : 1943 " Flow Measurement."

(4) When the average velocity in feet per min. has been determined, the nearest size of sampling nozzle should be selected from the graph (Fig. 2) which shows nozzle diameter against sampling volume. The sampling volume used should be 84 cu. ft./min. at 70 deg. F. under normal operating conditions.

(5) The nearest size of nozzle as indicated on the graph should be fitted to the probe, and the flexible metallic tube extended to the probe connected to the cyclone inlet. A check should be made that the filter bag is attached to the ring inside the aluminium casing. and the access-door replaced and checked for gas tightness.

(6) From the graph, Fig. 3, the pressure drop across the cyclone can be determined appropriate to the operating temperature determined under (2) above, and the sampling volume measured as under (4) above.

(7) Position the sampling probe centrally into the duct or flue, the probe to face upstream.

(8) Switch on the fan and adjust the fan outlet damper to obtain the required pressure drop across the cyclone as in (6) above, and run the unit for approximately 10 min. to condition the filter bag to the gas conditions.

(9) Switch-off the fan and remove the sampling probe from the duct or flue. Remove the filter bag and weigh immediately ; also remove the bottle removing any collected grit and weigh.

(10) Replace the filter bag, bottle, and access-door and re-insert the probe as in (7) above ; switch on the fan and run the unit for a period of 30 min. maximum or until the bottle is between one-third and half full of grit and dust. During the period of test the cyclone pressure drop as indicated by the manometer should be maintained at a constant figure by adjusting the fan damper.

(11) Switch-off the fan, remove the bag and bottle and re-weigh immediately.

To determine:—(a) Collection efficiency per cent. of the cyclone tube, and (b) inlet grain loading to the unit in grains per cu. ft., i.e., grain loading in the sampled gases.

(a) Let W = weight of grit collected in the bottle in grams.

Let X = weight of grit collected in the bag in grams.

Let T = time of test in minutes.

Let Q = sampling volume in cu. ft./min.

Let E = collection efficiency (per cent.) of the cyclone tube.

Let G = inlet grain loading to the cyclone tube in grains per cu. ft.

Then $E = \dfrac{W}{W \times X} \times 100$ per cent.

and $G = \dfrac{14.53\ (W \times X)}{Q.\ T.}$

N.B. Where conditions are not ideal as in (1) above, a number of sampling tests at separate points on the same cross-section of the duct, or flue or stack, will provide a more accurate average, and subsequent sampling as below should be carried out at the position most nearly relative to that providing an average concentration figure.

(b) When the collection efficiency test has been carried out as indicated above, and the collection efficiency for the cyclone tube determined, then subsequent tests where general operating conditions are similar to those experienced during the former test can be run, without use of the filter bag, using the cyclone tube only (the filter bag being removed from its spigot inside the aluminium housing). The grain loading in the effluent gases is calculated by using the relationship between the already proven efficiency of the cyclone tube and the weight of grit collected in the bottle by the D.584 cyclone tube.

The calculation on this basis to provide the grain loading would be:—

$$G = \frac{1543\ W}{Q.T.E.}$$

In the first instance, it is anticipated that the detailed procedure to determine the efficiency of the cyclone tube and the initial figure, if required, of grain loading, would be carried out by a suitably qualified member of a research or engineering staff on site who, with very simple instruction, could then arrange for routine sampling, by use of the single cyclone tube only and the formula under (b) above, by a responsible plant operative.

The Institution of Electrical Engineers, Savoy Place, London, W.C.2, is organising a convention " on the impact of nuclear development on electricity supply and on instrument techniques " to be held in London in September, 1961. Among the subjects to be discussed will be present and future energy requirements in relation to energy resources available ; economics ; operating characteristics ; the siting of nuclear power stations and its effect on system planning ; health physics ; radiation detectors ; pulse circuits ; nuclear measuring instruments for research, processing control, and for prospecting and mining applications ; instruments for nuclear reactors and associated plants ; and data processing for nuclear applications. Visits of technical interest will be associated with this convention.

A booklet recently published by **Henry Wiggin & Co. Ltd.** provides basic information on " Wilco-Wiggin Thermometals," a brief description of the various grades and a series of tables showing the thermal properties, formulae for various shapes and temperature-deflection. Short articles on fabrication, heat treatment and mounting are included in this publication which can be obtained free on request from the publicity department of the company at Thames House, Millbank, London, S.W.1.

* * *

Plenty & Son Ltd., Newbury, Berks., announce the retirement of **Mr. W. H. S. Aplin,** after more than 20 years' service. **Mr. J. F. Hall-Craggs,** who has been elected to fill the vacancy on the board, is the director in charge of the company's Filter and Chemical Plant Division.

Mr. A. E. Bates, M.I.E.E., has been appointed manager of The English Electric Company's office in Edinburgh. Mr. Bates succeeds **Mr. W. M. Todd** who was recently transferred from Edinburgh to manage the company's Bristol office.

* * *

Mr. A. H. Stafford has been appointed secretary of the Eastern, London and South-Eastern Region of the Central Electricity Generating Board.

* * *

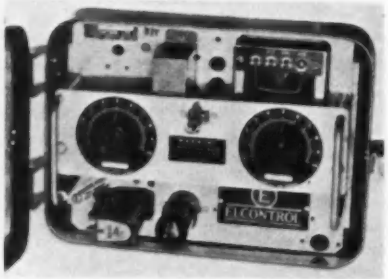
Elcontrol Limited announce that **Mr. B. A. Worswick,** B.Sc. (Hons.), A.Inst.P., has been appointed technical director of the company. Mr. Worswick was until recently chief engineer of Fischer & Porter Limited, and previously was chief development engineer of Bailey Meters & Controls Limited.

RECENT Equipment AND Accessories

Overload and underload relays

Current overload and underload relays available from Elcontrol Limited comprise an electronic relay unit housed in a steel case, together with a separate current transformer. In both forms of relay unit, the relay is energised when the monitored current is within the desired limits. If the current exceeds the pre-set value in the case of the overload relay (OR3), or drops below it in the case of the underload relay (UR3), the relay is de-energised. It automatically resets when the current

Fig. 1 (below). The OR/UR relay open to show interior. (Elcontrol Limited.)



falls in one case, or rises in the other to another pre-set value. The relay units contain two control knobs, one controlling the overload or underload value (i.e., the trip point), while the other controls the re-set or differential value. The controls are not calibrated. The operating or trip point of both forms of relay can be set anywhere between 20 per cent. and 120 per cent. full-load current, and the current transformers are normally rated at 100 per cent. overload. The differential is adjustable between 2 per cent. and 100 per cent. of the tip value. Both units can be arranged for manual re-set if desired. (*Elcontrol Limited, Hitchin, Herts.*)

New range of electric motors

A new range of totally-enclosed fan-cooled motors which are smaller, lighter and cheaper than existing motors of the same type is announced by The English Electric Co. Ltd. The dimensions of the new motor are exactly the same as the "C" type ventilated motor (British Standard 2960) and the two types are, therefore, interchangeable. The new motors, known as type "D," have outputs up to 100 per cent. greater than existing motors of the same size, type "B." The greater outputs have been achieved by allowing for a temperature rise of 65 deg. C. above 40 deg. C. instead of the existing 55 deg. C. This results from the use of class "E" insulation instead of class "A." The special features are an all cast-iron exterior with finger-proof cowls, a plastic (polyester) non-corrosive external fan, a terminal box of weatherproof construction with four screw fixing bolts, drain

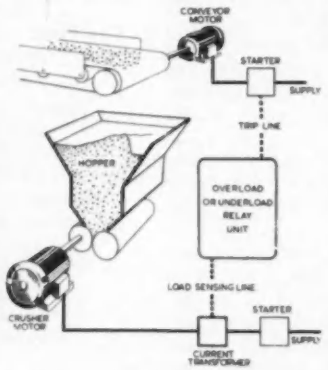


Fig. 2 (above). Diagram showing use of relay unit in a typical industrial application. (Elcontrol Limited.)

holes with easily detachable plastic plugs, and provision for an earthing terminal. The range of outputs is covered by twelve frame sizes, viz., two-pole—1½ to 30 h.p.; four-pole—1 to 40 h.p.; six-pole—½ to 25 h.p.; and eight-pole—½ to 20 h.p. The motors can be wound for operation on any two- or three-phase supply up to 650 volts at 50 and 60 c/s, and they are also available for any specific frequency such as the 25 c/s or 40 c/s supply. They will give an average starting torque of approximately 200 per cent. full-load torque with an average starting current of 700 per cent. full-load current when started direct-on-line. High-torque motors will also be available where special starting characteristics are required. Production of foot-mounted motors up to 10-h.p. has already started. Other outputs and mountings—foot, flange, skirt, foot and flange, pad and airstream rated—will follow. (*The English Electric Co. Ltd., Marconi House, Strand, London, W.C.2.*)

Magnetic separator

Rapid Magnetic Limited announce an addition to their range of magnetic equipment. Known as the APS, a new separator has been designed specifically to handle high throughputs of fine mesh material containing a high percentage of magnetics and demanding severe agitation after pick-up in order to ensure a clean, high-grade magnetic fraction. Throughputs of up to 30-tons/hr. are possible on an 18-in. wide machine. The Rapid Alternate Pole Magnetic Separator consists of a self-discharging electro or permanent polarity magnet unit suspended at the terminal end of a short centred conveyor. A hopper with jig shaker-feeder is provided and dividers are incorporated at the point of discharge for collection of high grade non-magnetic fraction and middling product if required. Where feed conveyors are already available the Overband Magnetic

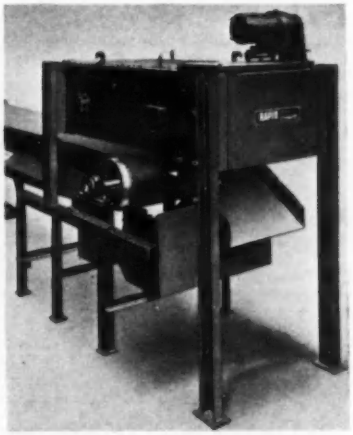


Fig. 3. The Rapid Magnetic APO alternate overband separator. (Rapid Magnetic Limited.)

Unit can be offered separately. This is designated the APO Alternate Overband Separator. (*Rapid Magnetic Limited, Lombard Street, Birmingham, 12.*)

Non-destructive testing of thick materials

The 31 MEV Betatron, manufactured by Brown Boveri & Co. of Switzerland, is now available in the United Kingdom through Watson & Sons (Electro-Medical) Limited. It

is suitable for the non-destructive testing of very thick materials, and for research with high-energy X-rays and electrons. The radiation energy is adjustable up to 31 Mev. and in some models up to 35 Mev. Steel can be radiographed up to a thickness of 20-in. At full output and focus to film distance of two metres, radio-

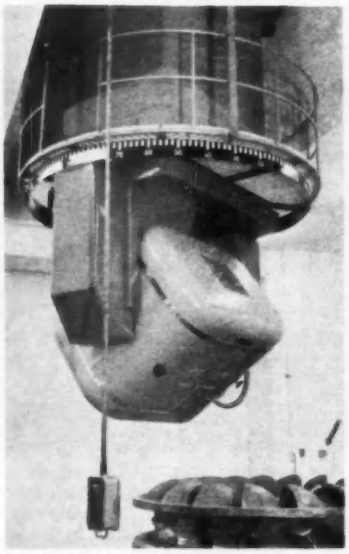


Fig. 4. A 31-Mev. Betatron for the non-destructive testing of thick materials. [Watson & Sons (Electro-Medical) Limited.]

graphs of 8-in. of steel can be obtained in 4 min. with a density of two, and in 30 min. with 12-in. of steel. The instrument has two focal spots, each 0.1 mm. × 0.3 mm. The wire penetrameter (DIN) sensitivity over a thickness range of 6-in.-14-in. of steel is almost constant at 0.3 per cent. At 10-in. steel a 0.03-in. dia. wire can still be seen. The very small focus size allows X-ray magnification to be used, and thus further improvement in sensitivity can be obtained. This apparatus is also used for nuclear physics studies, including photo-nuclear reactions and generation of Cerenkov radiation. It has also been used to study biological processes induced by high energy X-rays and electrons as occur, for example, in therapy and genetic changes. A Betatron producing electrons and X-rays up to 35 Mev. is available for cancer therapy. A detachable beam equaliser may be used and provides a beam of intensity constant to within ± 5 per cent. over a circle of 8-in. diameter at 1 metre from the target. The dose rate measured with a thimble chamber surrounded by 3 mm. of lead is at least 62 r/min. at 1 metre distance. Shutters in each beam control the beam height. For setting-up purposes, two light beams are projected along the centres of the X-ray beams. The targets are 531 mm. apart and produce X-ray beams converging to a point at 2.4 metres distance. They may be used separately or simultaneously. In the latter case, two parts of a specimen are radiographed producing a double field, or stereo radiographs may be made. A control desk contains sequence switches and a delay timer for controlling the magnet field, electron injection and orbit expansion. Ion chambers are fitted in the Betatron head in each beam, and the dose rate and dose are indicated for each on separate meters on the control desk. The exposure may be terminated by the dosemeter (0-10,000 r) or a timer (0-55 min.). The power consumption is 16-kW, and cooling is by a built-in fan. The basic X-ray head can be rotated by motor drive about horizontal and vertical axes, and mounted on a crane or gantry. Auxiliary equipment includes a condenser bank and cabinets containing electrical equipment for electron injection and orbit expansion. [*Watson & Sons (Electro-Medical) Limited, East Lane, North Wembley, Middlesex.*]

Transistorised recorder

The Fielden Capacipoise Servograph is a compact servo-operated recorder available in a.c. or d.c. current ranges, and designed to fit into the Capacipoise range of instruments, all of which operate from a

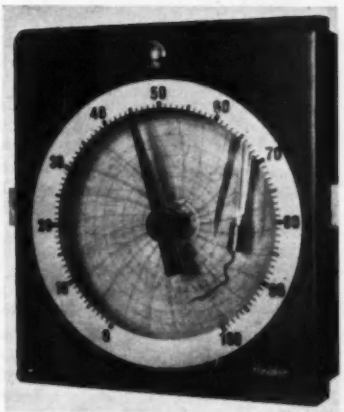


Fig. 5. The new Fielden transistorised d.c. Servograph indicator/recorder/controller. (Fielden Electronics Limited.)

supply of 12 volts d.c. Two models are available, one requiring an external d.c. supply and the other incorporating its own power pack; the latter operating from the normal 240 volts, 50 c/s supply. The size of the instrument has been chosen to give a chart 6¼-in. diameter, which is large enough for the vast majority of applications, whilst the recorder itself will occupy a minimum of panel space. All instruments are fitted as standard with a central indicating pointer moving over an arc of 300°. The indicator scale length is approximately 15-in. and is easily readable from a considerable distance. One or two electrical contacts, which can be used for alarm or control purposes, can be fitted and other forms of control are also available. Both the pen and the indicating pointer are motor driven and no errors are introduced by pen to paper friction or by the weight of the pen. The servo-motor also ensures that extremely small increments are faithfully reproduced on the chart. In the design of the recorder, moving parts have been reduced to the minimum. Gearing between the servo-motor and the central indicating pointer has been eliminated by the use of a rim drive and a simple quadrant connects the indicating pointer to the recording pen. With this new design the instrument is very much more simple than conventional servo-operated recorders and, the company claim, can be depended upon to give long, trouble-free service without attention. Since the input is isolated from earth the Servograph can record any current or voltage normally indicated on a meter, and is quite suitable for recording the output of other electronic or electrical equipment such as pH meters, smoke density detectors, CO_2 indicators, Beta gauges, tachometers, etc. The minimum full scale deflection is 25 μA or 30m V. (*Fielden Electronics Ltd., Paston Road, Wythenshawe, Manchester*, 22.)

A new series of steels

The United Steel Companies Limited, in collaboration with Samuel Fox and Co. Ltd., a United Steel subsidiary, have developed a range of high-strength stainless-steels, known as the Jethete series of steels, for service at elevated temperatures. These are low-carbon 12 per cent. chromium-nickel steels, containing additions of molybdenum, vanadium, niobium and other elements as may be required to produce various desired properties. Jethete M.151 is a low-carbon 12 per cent. Cr-Ni-Mo-V composition, in which the composition is controlled so that the structure is fully-austenitic at solution and welding temperatures. On the other hand, the tempering resistance is not so great as to prevent softening prior

to fabrication. The major use of this material is in sheet form, where it must be capable of softening for fabrication by pressing, but the full mechanical properties can be recovered by a relatively simple heat treatment, which does not involve too high a solution temperature. Jethete M.152 is a development from Jethete M.151, having a similar composition but with high impact properties and a low transition temperature. The improved impact level is advantageous when producing large sections. Jethete M.153 is a 12 per cent. Cr-Ni-Mo composition, with higher impact properties and a slightly lower cost than Jethete M.152. The high-temperature properties of the 12 per cent. chromium steels are quite reasonable in the 400-500 deg. C. temperature range, but Jethete M.160 a 12 per cent. Cr.-Ni-Mo-V-Nb composition, meets the demand for higher temperatures, the niobium addition providing the improved high-temperature strength. For still higher temperatures, particularly those experienced with aircraft engines, the latest material in the series is Jethete M.210, a 12 per cent. Cr-Ni-Mo-Co-B composition. The steels in the series are, the company claim, being employed increasingly for such applications as the manufacture of low-pressure turbine blading. (*The United Steel Co. Ltd.*, 17, *Westbourne Road, Sheffield*, 10.)

Relief valve

A new relief valve known as the 10HV, is now available from The Plessey Co. Ltd. It has a working temperature of 0-100 deg. C. This new addition to the range of valves manufactured by Plessey has been designed by the company's Industrial Hydraulics Division to meet the demand for a compact and stable

Fig. 6. The new 10 HV relief valve. (Plessey Co. Ltd.)

pilot-operated relief valve capable of accepting flows of up to 10 gal./min. with a pressure range of from 100 to 3,000 lb./sq. in. A feature of the new valve is its flat characteristic over a wide flow range. (*The Plessey Co. Ltd., Ilford, Essex.*)

New industrial motors

Crompton Parkinson Limited announce the development of a range of totally-enclosed, fan-cooled, industrial a.c. motors with Class "E" insulation, which are claimed to develop up to twice the power of previous standard totally-enclosed machines of equivalent frame size. The new motors, designated Series 5 T.E.F.C., are substantially smaller and lighter, and on average 9½ per cent. lower in cost than the machines they supersede. Electrically, the motors conform to B.S. 2613 : 1957 Class "E" insulation. Dimensionally, they conform to a new B.S. draft specification, and their fixing dimensions are the same as Series-5 ventilated-motors to B.S. 2960 : 1958. The cooling of Series-5 T.E.F.C. motors

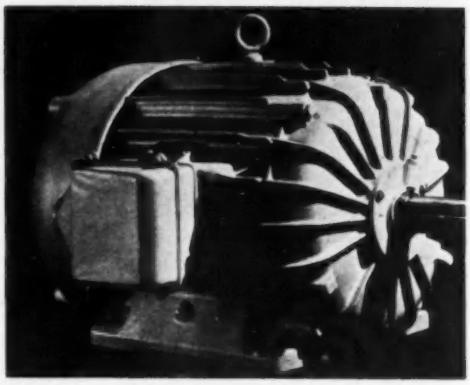


Fig. 7. A model from the new Crompton Parkinson range of motors with Class E insulation. (Crompton Parkinson Limited.)

is particularly effective, an entirely new design of fan having been evolved which promotes a very high velocity stream of air which remains in intimate contact with the motor carcase over its whole length. Rapid transfer of heat from the centre to the outside of the motor is promoted by, among other factors, an interference fit of the stator stamping packs in the housings. The efficiency of the cooling system has made it possible to dispense with the usual longitudinal cooling fins on the outside of the motor carcase on motors up to Frame 184. The standard rotor provided is suitable for the majority of normal applications, but by variation of the rotor design, it is possible to provide different starting characteristics to suit special requirements of driven machines. As from January 1st, 1960, Crompton Parkinson Limited are making the new range of Series-5 T.E.F.C. motors available in ratings from 1 to 7½-h.p. at 1,400 r.p.m. The remainder of the range, 10-h.p. to 40-h.p. at 1,400 r.p.m., will be made available later in the year. (*Crompton Parkinson Limited, Crompton House, Aldwych, London, W.C.2.*)

Self priming pump

The Pep-Loewe range of centrifugal pumps has been increased by the addition of a new vertical self-priming unit, the VRL.225. The new pump is designed for general purpose pumping duties and is suitable for handling clear or cloudy liquids with temperatures up to 220 deg. F.; fuel and diesel oils and other oils up to 450 seconds Redwood No. 1; and, due to its self-priming characteristics, can be used to handle volatile liquids. The pump primes quickly, the dynamic suction-lift amounting to as much as 28-ft. when pumping cold liquids. The capacities and heads available are 70-gal./hr. at 100-ft. of liquid and 400 gal./hr. at 25-ft. The VRL.225 occupies less than 1 sq. ft. of space, which is of considerable advantage where a unit of comparable power has to be installed in a confined area. New features are the casing which is designed so that if the foot valve on the suction line should be inoperative, the pump will continue to work; the impeller, specially shaped and fitted with very short blades to prevent breakage on bending, and also fixed so that it is not in contact at any point with the casing with, consequently, no wear on the impeller; the pump and motor shafts cannot become misaligned since they are rigidly coupled by a new type of special split coupling. The pump is normally fitted with a ½ h.p. three-phase motor, but if required either single-phase a.c. or d.c. motors can be fitted. [*Precision Electrical Products (Stockport) Ltd., Lytham Street, Cale Green, Stockport.*]

Instrumentation for open-hearth furnace

An example of steel-making plant equipped with instrumentation and automatic control by George Kent Limited, is the recently-commissioned open-hearth furnace at the Glamorgan works of the Briton Ferry Steel Co. Ltd. The instruments which control the 100-ton oil-fired furnace are housed as a single unit in a combined cabin-type panel and plate-glass-fronted control cubicle. Various instruments from the company's range are used to indicate and record pro-

cess variables—roof temperatures, checker temperatures, combustion air, oil flow, steam flow, furnace pressure, etc.—and the Kent system of automatic control is provided to ensure over-all efficiency. Two features of the installation are: (1) The provision of a direction-of-firing automatic reversal system initiated by a Multelec Mark 2 temperature-difference instrument (with over-riding reversal on time interval) working in conjunction with two land radiation pyrometers; and (2) a Commander KE electronic liquid-steel temperature indicator with a range of 1,250-1,750 deg. C. Accessories such as selector switches, manual reversal switches, push-buttons for door opening and pneumatic auto/manual/test/service stations are externally-mounted on a forward control desk, enabling instrument readings to be observed and any required adjustments to be made without entering the cubicle. Positioned on anti-vibration mountings, of the Silent-Bloc pattern, the instrument-panel/control-cubicle assembly also embodies over-all panel lighting; individual instrument illumination; sealed, locking doors; and automatic pressurisation for dust exclusion. (*George Kent Limited, Luton, Bedfordshire.*)

New vibratory conveyor

A new type of vibratory conveyor, which is claimed to be considerably cheaper than the conventional magnetic design, has been developed by Sinex Engineering Co. Ltd. Known as the Sinex vibratory conveyor, it has all the advantages of the magnetic conveyor (except that it has a fixed rate of feed), i.e., few moving parts, low maintenance requirements and silence of operation. It is particularly adaptable where very little headroom is available. Applications for which it is specially suited are those involving the simple transfer of material from one point to another; the feed can be stopped or started at will; and although the speed of travel remains constant the level of material can be altered by means of a gate to control the amount being fed. The vibratory conveyor, the length of which is adapted to customers' requirements, comprises a feed-trough fitted with a pair of the new standard SV range of Sinex electric vibrators, one on each side of the trough. The vibrators are mounted with their shafts in a vertical plane but inclined at a specific angle to provide a feed of material in one direction along the trough. Each conveyor can be supplied complete with base structure or with simple mountings for attachment to the customer's own equipment. The only moving parts employed are the rotors of the vibrators. Vibrators can be quickly replaced if this eventually becomes necessary, by virtue of their four-bolt lug mountings. (*Sinex Engineering Co. Ltd., North Feltham Trading Estate, Feltham, Middlesex.*)

Automatic air-filter

A new automatic air-filter, known as the "Autoroll," and available from Vokes Limited, comprises a filtering medium disposed between two spools. Passage of the clean filter medium from the top spool, across the air-flow aperture, and on to the lower spool is effected automatically by means of a geared motor drive which operates intermittently on a time-cycle, or by a pressure-differential switch. The filtering medium is in the form of a muslin-backed, fibrous mat, the dust-collection and retention characteristics of which are enhanced by the application of a stabilised wetting fluid before spooling. Some 125-ft. of standard filter-medium can be accommodated on a spool of 12-in. dia. The "Autoroll" is manufactured in standard widths of 3-ft., 4-ft. and 5-ft., and in heights varying from 6-ft. to 15-ft., each standard section being designed for erection into banks of vertical units. A vane-type switch fitted at the top of the unit is provided to give an audiable (or visual) indication that servicing is required, while the at same time, the motor circuit will be isolated to prevent further take-up, with filtration continuing at an increasing resistance until a new roll is fitted. A free-wheel sprocket is provided on the lower, or take-up spool to allow rapid rotation of the spool by hand, without the necessity to isolate the driving mechanism. A further isolating switch is incorporated, which can be operated for servicing or under emergency conditions. A manually-operated "Autoroll" is also available, in which a few movements of a ratchet-lever enables clean filter material to be "inched" downwards into the air-stream. The amount of new material introduced can be assessed by reference to a simple manometer. (*Vokes Limited, Henley Park, Guildford, Surrey.*)

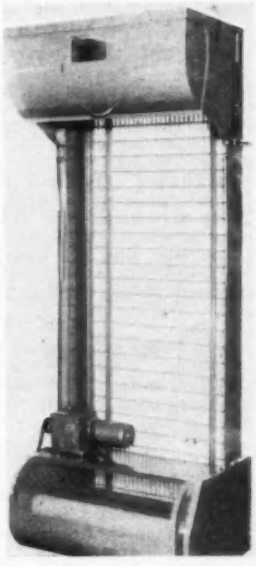


Fig. 8. The Vokes "Autoroll" automatic air-filter. A manually-operated unit of similar design is also available. (Vokes Limited.)

Bench-mounted grinder

A new air-operated grinder for mounting on work benches has been introduced by the Consolidated Pneumatic Tool Co. Ltd. Known as the 3190M, this new equipment has a 6-in. dia. wheel which has a width of 1-in., the free operating speed being 4,500 r.p.m. The total height of the unit is 9 $\frac{1}{16}$-in. and the weight, including the guard, is 12-lb. The diameter of the air inlet connection is $\frac{1}{2}$-in. Power for the tool is developed by a vane-type motor, particular features of which are the constant-speed governor which maintains the wheel at the most efficient cutting speed from "no load" to "full load," and eliminates the possibility of over-speed when running free; a heavy valve spring and loose fitting valve which prevents the valve from being jammed by foreign matter; and a neoprene "O" ring which gives a leakproof valve seal. Whilst the drilled baseplate on which the grinder is mounted makes it particularly suitable for attaching to portable compressors for the maintenance of tools, such as the touching up of drill steels, breaker points, etc., it is also expected to find a wide general application where occasional bench grinding tasks exist and where a supply of compressed air is available. (*Consolidated Pneumatic Tool Co. Ltd., 232, Dawes Road, London, S.W.6.*)

Voltage controlled overcurrent relay

The Meter, Relay and Instrument Division of The English Electric Co. Ltd., has added to its range of relays, an overcurrent relay designed to protect alternators against both overload and short circuits. When used for main or back-up protection

of alternators, overcurrent relays have often to meet the conflicting requirements of giving adequate fault settings on loads close to full-load, and giving normal overload protection. This is because the sustained short circuit on external faults may be limited to a value below full-load. For full protection against overload and short circuit conditions, measurement of current alone is insufficient. This new relay, known as the CDV22, also measures the terminal voltage. It is basically the type CDG standard inverse time - overcurrent relay equipped with a voltage sensitive element which permits it to discriminate between overload and short circuit conditions. To take advantage of the thermal capacity of most alternators, the operating time under overload conditions is longer than the corresponding time provided on a standard inverse time-overcurrent relay. Under short circuit conditions, a fast operating time is provided. This form of protection can be applied to solidly or resistance earthed alternators. (*The English Electric Co. Ltd.*)

Mr. W. H. C. Pilling, B.A. (Hons.), M.I.E.E., has been appointed chief project engineer of the Northern Project Group of the Central Electricity Generating Board. From 1928 to 1948 Mr. Pilling was with the Yorkshire Electric Power Company, holding the positions of assistant engineer, and chief assistant to the construction engineer at the head office. On Vesting Day he was appointed deputy generation engineer (Construction), and in 1949 was promoted to generation engineer (Construction), Yorkshire Division. From December, 1951 to April, 1954, he was with the Merseyside and North Wales Division, holding the post of chief generation engineer (Construction). With the merger of that division into the North West, Merseyside & North Wales Division, he became deputy chief generation engineer (Construction). In August, 1955, he transferred to headquarters as nuclear projects engineer, and held the position until March 1st, 1958, when he was appointed assistant chief project engineer, Southern Project Group.

* * *

Associated Electrical Industries Limited have appointed **Sir Arthur Elton,** Bart., to be the controller of their Central Information Department, 33, Grosvenor Place, S.W.1. He will take up his duties on March 1st. Sir Arthur Elton has, for the last three years, been in charge of films and television in the Public Relations Division of the Shell International Petroleum Company. For nine years before that, he was chairman of the Film Centre and in that capacity was adviser to Shell and other companies.

* * *

An order for the supply of five sets of combined change-over and safety-valves for the United Kingdom Atomic Energy Authority has been received by **Cockburns Limited,** Cardonald, Glasgow. The valves, which are for the Authority's Windscale establishment, are for service with radio-active CO_2 gas in the advanced gas-cooled reactor. Operating temperature is 760 deg. F., and the valves, which have special alloy-steel chests and internal components, will be set to "blow off" at 280-lb./sq. in. The safety valves are Cockburns patent full-bore type, with deadweight control valves. The company are well-known as suppliers of multi-purpose valves, and have produced designs which combine full operating efficiency with extreme compactness. As many as five valves have been combined in one chest. In addition to this order for Windscale, Cockburns have supplied valves and fittings to the nuclear power stations at Bradwell, Hinkley Point and Hunterston.

An agreement has been concluded between **Kelvin & Hughes Limited,** and the **Curtiss-Wright Corp.** of America, for the exclusive right to manufacture and sell the non-destructive testing equipment of the other partner. This includes instruments for the inspection and measurement of materials, and equipment employing ultrasonic techniques in all industrial fields. The agreement covers certain defined territories; Kelvin Hughes will represent both interests in the U.K., the Commonwealth (except Canada) and Europe, and Curtiss-Wright in the U.S.A. and Northern America. Each party to the agreement will offer full sales and service facilities on the joint range of equipment. Kelvin Hughes has developed a range of manual, semi-automatic and automatic ultrasonic test equipment. Curtiss-Wright also manufactures ultrasonic equipment but has, in addition, a range of industrial radiographical equipment using X-ray and Gamma-ray techniques. Immediate advantages of the new partnership will be that the equipment available from both organisations for non-destructive testing will be greatly increased.

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Mr. E. T. Judge has been appointed joint managing director of Dorman Long (Steel) Limited, and an executive director of the parent company, Dorman Long and Co. Ltd.

* * *

Glenfield and Kennedy Limited announces the following appointments to the board of the company: **Mr. John H. Lawrence, Mr. Donald A. S. Maclellan, Mr. James C. Robertson** and **Mr. James G. Workman.**

* * *

The British Electrical and Allied Manufacturers' Association Export Panel states that **Mr. D. Maxwell Buist** has retired from the chairmanship and has been succeeded by **Mr. E. V. Small. Mr. L. H. Short** has been elected vice-chairman.

* * *

Laurence, Scott and Electromotors Limited announce that **Mr. H. M. Medhurst,** sales engineer, has retired.

* * *

Mr. Edwin E. Hewett has been appointed sales engineer of Nash & Thompson Limited, Hook Rise, Tolworth, Surbiton, Surrey.

* * *

Mr. J. E. A. Heale, formerly works manager of the Motherwell works of Metropolitan-Vickers [now A.E.I. (Manchester) Limited], has joined Associated Electrical Industries (Woolwich) Limited, as general manager of works.

Sir John Charrington has relinquished his position as managing director of Charrington, Gardner, Locket & Co. Ltd., but will continue as chairman. **Mr. K. M. Stobart** has been elected vice-chairman. **Mr. K. M. Stobart, Mr. H. D. B. Lorraine** and **Mr. John Charrington** have been appointed managing directors, and **Mr. C. P. Humphris** has joined the board.

* * *

Markland Scowcroft Limited, general engineers and merchants, Cox Green Works, Bromley Cross, Nr. Bolton, have been appointed by **Hattersley (Ormskirk) Limited** as stockists of their comprehensive range of Hattersley gun-metal and cast-iron valves, which includes their newly introduced range of gun-metal radiator valves.

* * *

Dr. Maurice Cook, who has been chairman of I.C.I. Metals Division for the past two years, retired from the company's service on December 31st, 1959. He is succeeded by **Mr. Michael Clapham,** a joint managing director. **Mr. G. A. D. Smith** has been appointed commercial managing director of the division. Mr. Smith joined the secretary's department of the division in 1936, and after completing military service in 1947, was appointed personal assistant to the commercial managing director of Metals Division. He was appointed to the board of I.C.I. Metals Division in 1951, and has since served as sales director and commercial director.

* * *

Mr. G. P. Davidson has been appointed managing director of Head Wrightson Processes Limited, with effect from February 1st, 1960. **Dr. R. C. Fisher** has been retained to act as adviser on nuclear research reactors and other nuclear projects.

* * *

The British Iron and Steel Federation announced that **Mr. R. F. Summers** has succeeded **Mr. Lewis Chapman** as president. **Mr. C. R. Wheeler** has been appointed president-elect of the Federation for 1960.

* * *

Karrena Furnace Engineering Limited, formerly of 789/797, Salisbury House, London Wall, London, E.C.2, have moved to Prince Rupert House, (2nd Floor), 65, Queen Street, London, E.C.4, tel. Central 7568 (3 lines).

* * *

The ninth **National Electrical Engineers' Exhibition,** which is to be held at Earls Court, April 5th-9th, 1960, will be opened by the President of the Board of Trade, the **Rt. Hon. Reginald Maudling,** M.P., at noon, on April 5th.

Latest Power Plant Patents

These extracts from British Patent Specifications are reproduced by permission of The Controller of H.M. Stationery Office. (Complete British Specifications can be obtained from the Patent Office, 26, Southampton Buildings, London, W.C.2. Price 3s. 6d. each, both inland and abroad.)

Feedwater Preheater

In steam generating plants, it is customary to use heat-exchangers for preheating the boiler feedwater by bringing it into heat-exchange relation with steam bled or extracted from a turbine, thereby improving the overall efficiency of the installation. For the best results, especially in the case of large multi-stage turbines, the heat-exchange has been effected in successive stages. It is an object of this invention to produce an improved feedwater heating apparatus in which a maximum number of heat-exchangers can be incorporated in one shell, whereby the cost of the apparatus itself is reduced and the apparatus will be compact, thus reducing building costs. In Fig. 1 is shown a conventional turbine-driven generator (10), a de-aerating condenser (12), condensate pumps (14), and an air-ejector (16). Steam is supplied to the turbine from the boiler by pipes (17) to (21) inclusive. Water from the hot-well of condenser (12) is delivered by pumps (14) and pipe (22) into header (23), which is located in the lowermost stage heater (24). Each of the various stage heaters is formed of similarly dished top and bottom walls (25), and a vertical wall (26) suitably welded together. The bottom of the lowermost stage is inversely dished as at (26). Header (23) is connected to header (28) by means of a number of spiral coils (30), some of which are shown in Fig. 3, and only one of which is partially shown in Fig. 2. Header (28) extends from lowermost stage heater (24) into the next stage heater (32) in which it is connected by coils (30) to header (34). This header extends into the next stage heater (33), where it is again connected by coils (30) to another heater (28), and so on, until the uppermost stage heater (40) is reached. If the vertical space available is limited, the apparatus can be made in more than one section as shown in Fig. 1. If this is done, header (42) in uppermost stage heater (40) is connected by pipe (44) to lowermost header (23′) which leads to another lowermost stage heater (24′). The desired number of stage heaters (32′, 33′, etc.) and headers (28′ and 34′) can be superimposed until uppermost heater (40′) is reached. Header (42), in stage heater (40′), is connected by pipe (52) to the suction side of pump (54), the discharge side of which is connected by pipe (56) to the boiler.

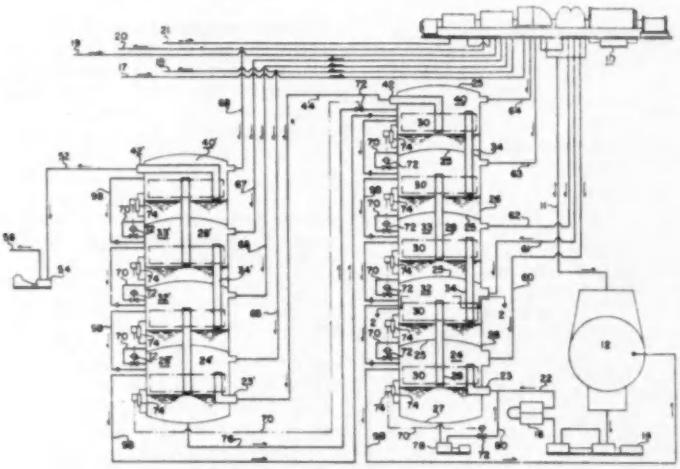


Fig. 1. British Patent No. 825,220.

In order to heat the water flowing through the various stage heaters, extraction steam is supplied to the successive stage heaters by pipes (60 to 68), the lowest temperature steam being delivered to stage heater (24) and the highest temperature steam being delivered into the stage heater (40′). As steam is delivered to each stage heater, it gives up its heat and condenses into water, and where sub-cooling is not desired, the level of condensate must be maintained below coils (30). This is conveniently effected by connecting each stage heater to the next stage by a pipe (70) provided with a diaphragm valve (72) which is opened by a " Levetrol " (74) in response to the level of the water in the various stage heaters. Thus, " Levetrol " (74) and valve (72) serve to maintain the level of condensate in the various stage heaters below the coils (30). When the installation is split into two sections, the pressure differential will expel the water from stage heater (24′) to stage heater (40). If the steam pressure differential is insufficient, a pump (not shown)

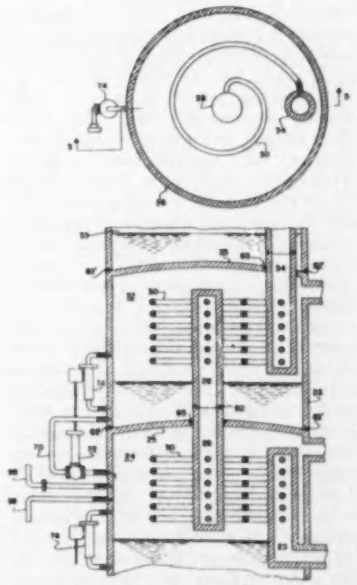


Fig. 2 (top). Fig. 3 (bottom). British Patent No. 825,220.

may be fitted in pipe-line (76) which leads from the bottom of stage heater (24') to stage heater (40). The "Levetrol" is a fluid level responsive device resembling a float in a water-tank. When the level in a heater rises, it builds up air-pressure in a tube, one end of which is near the bottom of the tank, and the other end of which has a diaphragm connected to a valve stem. The valve stem is biased to its seat by a light spring, and the pressure against the diaphragm unseats the valve which is reclosed by the spring when the pressure is decreased due to a lowering of the liquid level in the heater concerned. The condensate formed in, or ultimately reaching, stage heater (24), is delivered by pump (78) and pipe (80) to pipe (22), or directly to header (23), where it joins the condensate from the condenser (12). *British Patent No. 825,220 issued to H. A. Kuljian. Complete specification published December 9th, 1959.*

Forced-flow once-through boiler

This invention relates to a forced-flow once-through boiler installation. In an installation of this kind, it is often desirable to provide for the maximum degree of regenerative preheating of the water which is supplied to the boiler, but if neither the injected water nor the water required for the auxiliary heating surface is preheated, the total regenerative preheating will not be as great as it could be. In order to pre-heat the injected water, it may be conveyed, separately, from the main feed supply through some or all of a number of high-pressure heaters, which heat the main feed supply. However, it is also possible to provide for the injected water, one or more separate pre-heaters, which are connected in parallel with the main preheaters. It is particularly advantageous to provide for the injected water, a single, separate pre-heater connected to the upper bleed stage of the turbine. Since the water required for the auxiliary heating surface amounts to only about one-tenth of the injected water, the deviation from it does not result in any considerable loss. Figs. 4 and 5 show in simplified diagrammatic form two different forced-flow once-through boiler installations, Fig. 4 represents an installation in which the tube system of the boiler is subdivided into a preheater (1), a transition section (2), a preliminary superheater (3) and a final superheater (4). Connected to the final superheater (4) is a live-steam pipe (5). The feedwater which is pre-heated in low-pressure stages (not shown), is fed by the boiler feed pump (6) through a control device (10) and through a series of three high-pressure preheaters (7, 8 and 9) into the boiler. To allow for fine adjustment of the live-steam temperature, water is passed through a conduit (11) and is injected into the boiler tubing between the two superheaters (3 and 4). The quantity of water injected is regulated by a valve (12) in accordance with the live-steam temperature, as indicated by the dotted line (13). Auxiliary heating surface (14) is shown, the connection to this being branched-off upstream

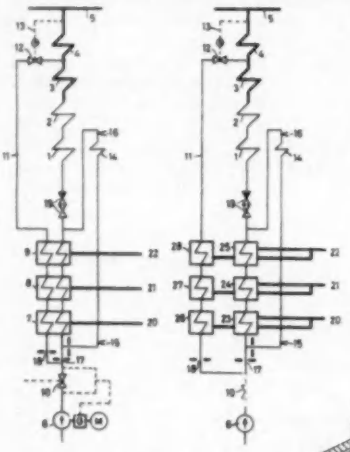


Fig. 4 (above, left). Fig. 5 (above, right). British Patent No. 825,465.

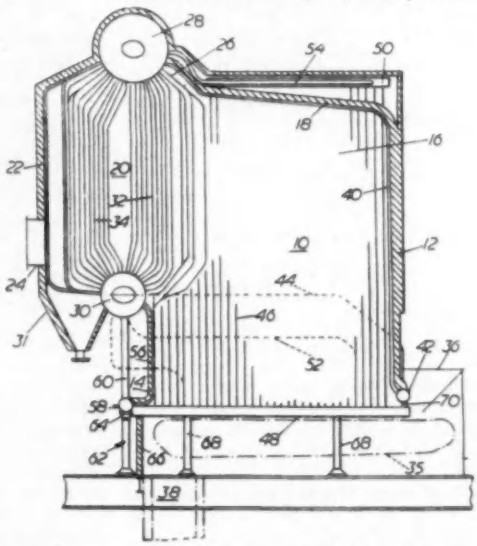


Fig. 6 (right). British Patent No. 825,811.

of the first high-pressure pre-heater (7). The temperature measuring points for the auxiliary heating surface (14) are designated as (15 and 16). There are provided metering orifices (17 and 18) for measuring the rates of flow of the feedwater and the injected water respectively. If adjustable feed pumps are used, there is no need for the control device (10). However, non-return and shut-off elements (19) are necessary in every case. In Fig. 4 the injected water conduit (11) is taken separately from the boiler feedwater conduit through all the high-pressure pre-heaters. The regenerative steam feed conduits are designated as (20, 21 and 22) and are connected to various bleed points of the turbines. Fig. 5 shows a circuit in which the pre-heating of the injected water is effected in separate high-pressure preheaters after quantity measurement has been carried out by means of the metering orifice (18). Whereas the pre-heaters (23, 24, 25) are provided for the boiler feedwater, separate high-pressure preheaters (26 to 28) are used for preheating the water flowing through the conduit (11). Where appropriate, a single high-pressure pre-heater may be adequate, connected for example, to the upper bleed stage of the turbine. *British Patent No. 825,465 issued to Siemens-Schuckertwerke A.G. Complete specification published December 16th, 1959.*

Bottom-supported boiler

Boiler and furnace tubes of a steam-generator are usually supported by the drums or headers to which they are connected. Some steam generators are supported from the lower drums and headers, while others are suspended from the upper drums. The large quantity of supporting steel required for top-supported steam generators makes such support arrangement somewhat expensive. Further, a top-supported steam generator requires relatively high headroom, and makes access difficult to some of the parts of the setting. Hitherto, in bottom-supported steam generators it has been

necessary to limit the difference in elevation between fixed supports to the lower drums and furnace walls to avoid excessive stresses on these, and associated parts, occasioned by relative expansion movements. This limitation imposes a definite restriction in the height of the furnace chamber, and consequently, a definite limitation in the steam generating capacities of such units. Fig. 6 is a sectional elevation of a bottom-supported steam generator embodying the invention, while Fig. 7 is a rear elevation of the lower-half of the bottom-supported steam generator shown in Fig. 6. The pressure parts of the steam generator are arranged for bottom support at substantially the same elevation, in order to minimise relative movements between different pressure parts due to thermal expansion. The points of support indicated in Figs. 6 and 7 are at the lower rear-wall header (58) and at the side-wall headers (48), the arrangement being such that the pressure parts are free to expand both vertically and horizontally. The predominant proportion of the weight of the drums (28, 30) and tube-banks (32, 34) (preferably most of the weight of these parts) is taken by a support arrangement including the upright supply tubes (60) which act as support columns and which are placed at spaced positions along the length of the drum (30) and the lower header (58). Vertical steel columns (62) are arranged at spaced positions along the length of the header (58) and have support saddles (64) at their upper ends below the header (58). Thus, the tubes (60) function as supply tubes in the fluid circulation system and as support columns for the drums (28 and 30), and the tube-banks (32 and 34). The tubes (60) are provided in sufficient number, and are of sufficient diameter and thickness to resist bending moment stresses in carrying the weight of the tube-banks and drums, and to withstand the compression forces transmitted to them. The rear end of the stoker is enclosed by a refractory wall (66) extending transversely of the furnace chamber (10) between the side walls. *British Patent No.* 825,811 *issued to The Babcock & Wilcox Company. Complete specification published December 23rd,* 1959.

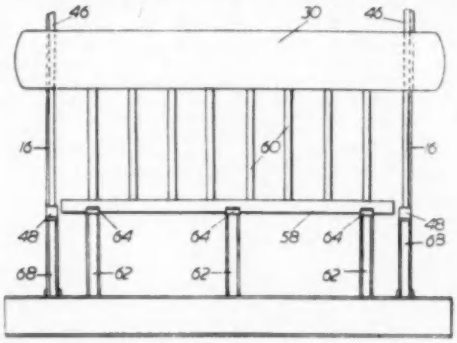
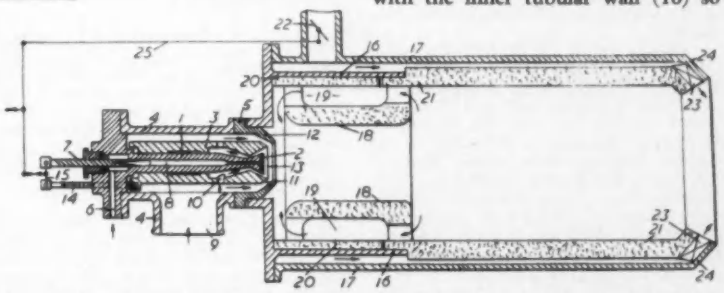


Fig. 7 (left). British Patent No. 825,811.

Fig. 8 (below). British Patent No. 825,880.



Combustion chamber

This invention relates to the production of hot gases by the burning of liquid fuel. The apparatus shown in outline in Fig. 8 comprises a two-fluid atomiser mounted co-axially with a tubular combustion chamber having internally a flame holder and means for back-circulation and re-entry of some of the gaseous products of combustion of the liquid fuel supplied by the atomiser. The atomiser comprises the liquid fuel conveying tube (1) adapted as a laterally spreading spray. There is also the co-axially surrounding air-conveying tube or casing (4) having a cap fitting centrally into the end wall of the combustion chamber. Fuel enters the tube (1) by the lateral supply passage (6) and the flow of fuel in the tube is regulated by the axially movable valve rod (7) having a V-notch in its forward end which slidably fits into the bore (8) of the fuel supply tube (1). Between the passage (6) and the bore (9) is a chamber or bore enlargement, so that the fuel passes into and through this chamber and is metered by the V-notch in the rod (7) as it passes into the bore (8). Air is supplied through the lateral inlet passage (9) in the outer air-conveying tube (4), some of the air then passing as atomising air through aperture or apertures (10) in the wall of the inner tube (3); the remainder of the air passes to, and through the annular gap (11) between the inwardly-coned mouth (12) of the cap (5) of the outer tube, and the inwardly-coned exterior of the outwardly conical mouth (13) of the inner tube (3). The inner tube (3) is mounted on the exterior of the fuel-tube (1), and its exit end or mouth is so shaped and dimensioned that when it is axially adjusted, it changes the volume of the air impinging on the fuel spray and also of the air passing through the gap (11). A rod (14) serves to effect axial adjustment of the inner tube (3), and this rod is linked, as shown at (15), to the axially-movable valve rod (7), so that a single setting movement affects the fuel supply and the air supply in constant proportion. The combustion chamber, into the end wall of which the above-mentioned atomiser fits, has an inner tubular metal wall (16) and an outer tubular metal wall or casing (17). The inner wall (16) is ceramic lined, and is provided with a flame holder in the form of a relatively short open-ended ceramic tube (18) co-axial with the inner tubular wall (16) so that the mixture of atomised fuel and air delivered by the atomiser enters the open-ended ceramic tube (18). After traversing the tube (18) and becoming vaporised, the mixture experiences a sudden increase in diameter of the flow passage. The construction is such that there is a space (19) between the combustion-chamber wall and the open-ended ceramic tube. This space is either a complete annulus, or is in the form of longitudinal flutings on the exterior of the open-ended ceramic tube, so that in either case some of the combustible mixture or products of combustion travel reversely along this space and re-enter the open-ended ceramic tube by entrainment. *British Patent No.* 825,880 *issued to R. P. Fraser. Complete specification published December 23rd,* 1959.

NOTES *Personal* AND *Industrial*

The Prime Minister (**The Right Hon. Harold Macmillan,** M.P.) has accepted an invitation to be the principal guest and speaker at the annual dinner of The Institute of Metals, which is to be held in the Great Room, Grosvenor House, London, W.1, on March 31st, 1960. **The United States Ambassador** has accepted to reply to the toast of "The Guests."

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Sir Owen Wansbrough-Jones, K.B.E., C.B., has been appointed a director of The British Oxygen Co. Ltd.

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Mr. A. I. Baker, C.B.E., J.P., M.A., M.I.Mech.E., has been elected president of the British Engineers' Association. Mr. Baker is chairman of Baker Perkins Limited. The retiring president, **Sir Edward Thompson,** J.P. (chairman and joint managing director of John Thompson Limited), has been elected honorary treasurer.

* * *

Mr. F. R. Bond has been appointed a director of Worthington-Simpson Limited. He retains his office as secretary. **Mr. H. D. Jenvey** has been appointed assistant secretary.

* * *

The John Thompson Conveyor Company has appointed **Mr. P. D. Hunter** as its London and Southern Area sales engineer.

* * *

Davey, Paxman and Co. Ltd. announce that **Mr. Harold Riggall** has resigned from the chairmanship and from the board of directors, on his retirement from the managing directorship of the parent company, Ruston and Hornsby Limited. **Sir Percy Sanders,** deputy chairman, has resigned for health reasons, but remains a member of the board. **Mr. W. J. Ruston** has been elected chairman, and **Mr. V. R. Prehn** has been elected deputy chairman.

* * *

Mr. W. S. Richards has been appointed managing director of Brightside Heating and Engineering Co. Ltd., of which company he has been a member of the board for some years. **Mr. James R. Nuttall** has been appointed secretary of Brightside Engineering Holdings Limited.

* * *

Mr. G. H. Hopewell, F.C.G.I., M.I.Mech.E., A.M.Inst.C.E., F.Inst.F., has resigned from the managing directorship of Foster Wheeler Limited and has been succeeded by **Mr. C. E. H. Verity,** O.B.E., M.Inst.C.E., M.I.Mech.E., M.Inst.F., who continues as manager, Steam Division. **Mr. R. B. Kerr,** M.B.E., has been appointed deputy managing director, and manager, Process Plants Division. Mr. Hopewell remains a director of the company, and becomes deputy chairman. **Mr. H. T. Collinswood** has retired from the position of manager, Process Plants Division, but remains a director of the company.

Mr. C. F. Kearton, O.B.E., who has been appointed chairman of the Electricity Supply Research Council, in succession to **Sir David Brunt,** has been a member of the Research Council since July, 1954, is a part-time member of the United Kingdom Atomic Energy Authority, and a director of Courtaulds Limited, and of other textile companies.

* * *

A.E.I. (Rugby) Limited, formerly the British Thomson-Houston Co. Ltd., announce the appointment of **Mr. D. Edmundson,** B.Sc., M.I.E.E., as general manager, Rugby works. This appointment will enable Mr. H. E. Cox, who has been general manager since 1957, to devote his time to the duties of deputy director of manufacture. Mr. Edmundson served an engineering apprenticeship with BTH, and in 1934 became a design engineer in a.c. Engineering Department, Rugby, and liaison engineer with Motor Department, Trafford Park, Manchester. In 1940 he was appointed head of the Electrical Laboratory, and in 1946, test engineer, Rugby Works, eventually becoming superintendent, Test Department. In 1957, Mr. Edmundson was appointed assistant manager—Manufacturing, being promoted manager—Manufacturing, on January 1st, 1959.

* * *

Dr. H. H. Burton, C.B.E., retired from the board of directors of English Steel Corporation Limited, on January 31st, but will continue as research consultant to the group until December 31st, 1960. **Mr. T. R. Middleton,** B.Sc., has been appointed a director of English Steel Corporation Limited, and director of research.

* * *

Bell's Asbestos and Engineering (Holdings) Limited, Bestobell Works, Slough, Bucks., announce that in order to provide for succession, all members of the Holdings company board over the age of sixty are relinquishing their board appointments in all the operating companies. **Mr. A. J. M. Miller** becomes the new chairman of Bell's Asbestos and Engineering Limited (operating company), and **Mr. D. Allen** and **Mr. F. R. Bedwell** have been appointed joint managing directors.

* * *

The name of **The British Vacuum Cleaner and Engineering Co. Ltd.,** Leatherhead, has been changed to—**Goblin (B.V.C.) Limited,** incorporating both "Goblin" and B.V.C. The name of the British Vacuum Cleaner & Engineering Co. Ltd. is being retained as a subsidiary company to market all industrial vacuum cleaners.

* * *

William Boby and Co. Ltd., water-treatment engineers, Rickmansworth (Herts.), have been awarded the contract to supply a complete demineralisation plant for the Earley power station, C.E.G.B. (Southern Division).

Mr. C. T. M. Bagnall, who has been publicity manager with The English Electric Company since 1952, is appointed to a new post of manager, Publicity and Information Services. This new title carries responsibility for both the company's Public Relations and Publicity Departments. This re-organisation follows the retirement of **Mr. J. I. Hall,** as English Electric's public relations officer on December 31st, 1959. Mr. Hall remains as a consultant to the group until March 31st, 1960, during which period he will spend some weeks on company business in America and Canada. Mr. Hall has resigned from his post to enable him to handle personal and family business. Four new appointments have been made in the Publicity and Public Relations Departments. **Mr. M. B. Schroeder** becomes joint deputy publicity manager (technical) and will continue to work from Stafford. **Mr. C. G. Hollowell,** who has been publicity manager of D. Napier & Son Ltd. since 1955 is appointed to the parent company as joint deputy publicity manager (general) working from Marconi House, London. In the Public Relations Department, **Mr. E. C. Roberson** will be deputy to Mr. Bagnall on public relations matters, and will continue to be responsible for the company's press relations in the atomic power field. **Miss Patricia Hardie,** who joined the Press Office in 1951, is now chief press officer.

* * *

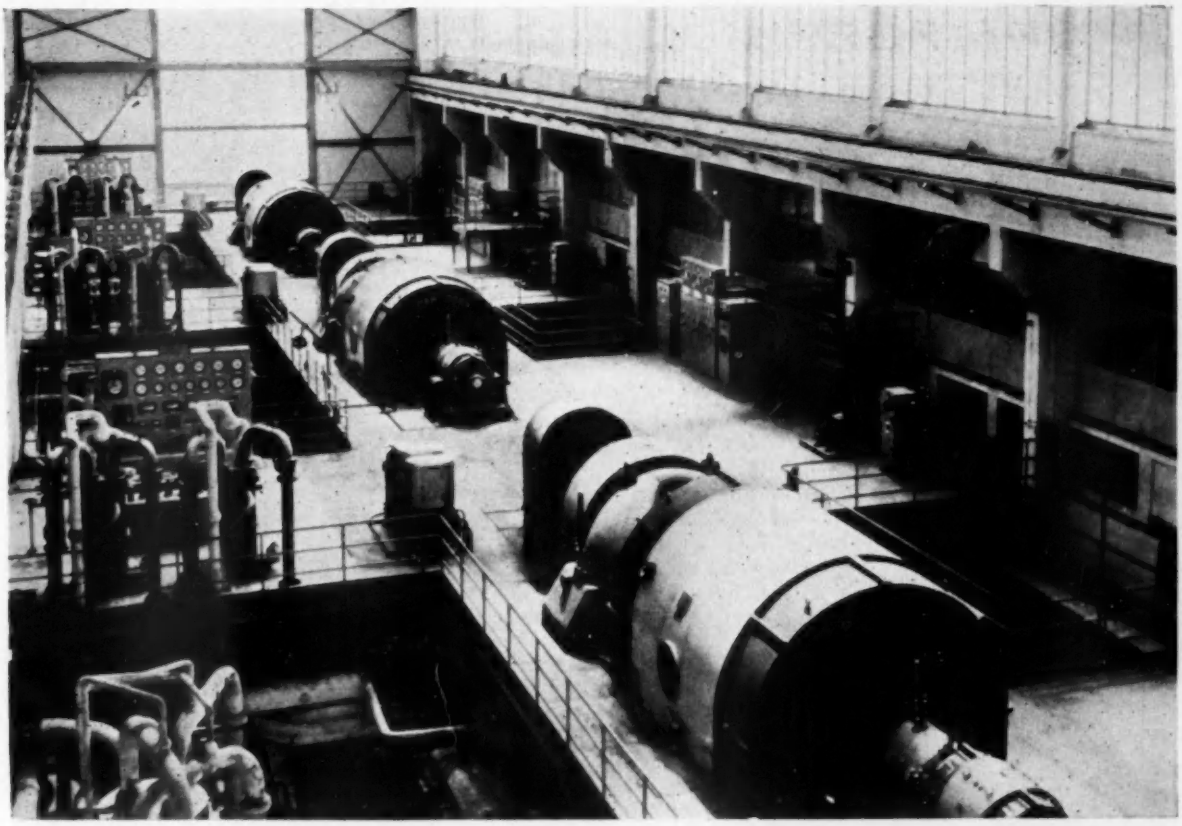
Crane Limited, 15-16, Red Lion Court, Fleet Street, London, E.C.4, well-known as manufacturers of valves, fittings, tubes, etc., have opened a new branch at Sweet Street, Leeds, 11, (telephone No. Leeds 3-5026). The new building, comprises a large warehouse block for the stocking of valves and pipe fittings, steel tubes, boilers and radiators, while there is also modern office accommodation, together with an attractive showroom where customers, architects, and members of the public can inspect a range of the company's products.

* * *

Mr. A. Davey, M.I.H.V.E., has been appointed joint managing-director of Norris Warming Co. Ltd., and **Mr. N. Aldcroft** has been appointed joint managing director of F. A. Norris & Co. Ltd. Both companies are subsidiaries of Norris Warming Holdings Ltd.

* * *

Pantak Limited, Vale Road, Windsor, Berks., have recently concluded an agreement with **Usines Balteau of Liege,** for the marketing in the U.K. of two ranges of lightweight portable industrial X-ray equipment. This equipment will complement their existing mobile units, and will consist of two oil-insulated units of 140 and 200-kV capacity and three gas-insulated units of 150, 180 and 300-MV capacity; the 180 kV unit being specially-developed for the examination of circumferential welds, etc.



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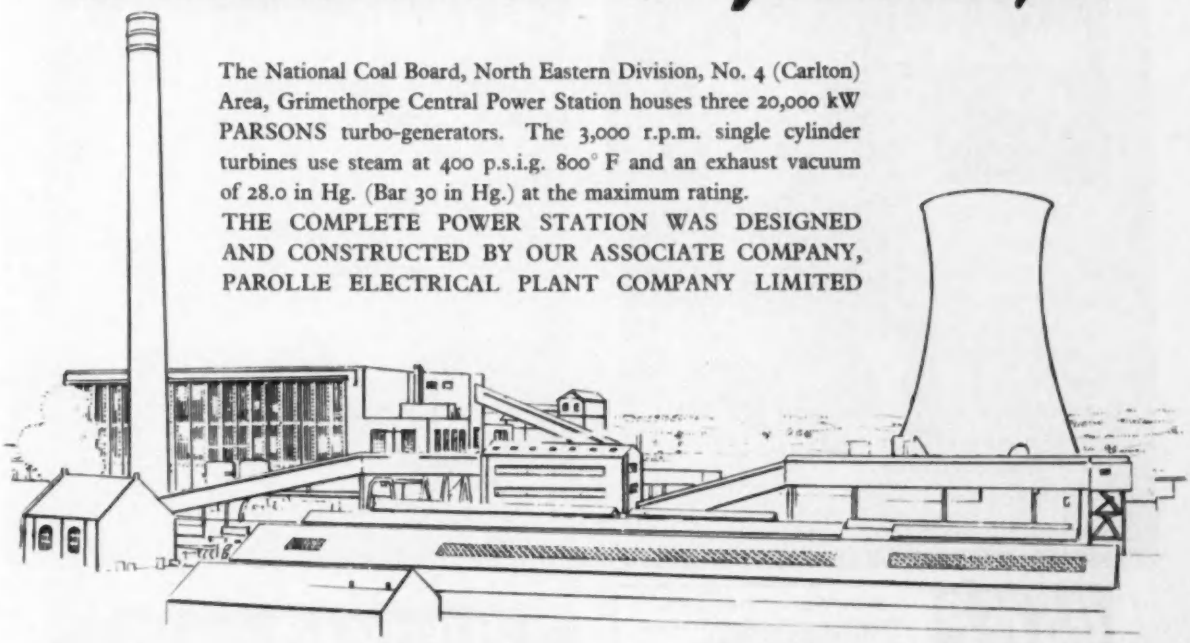

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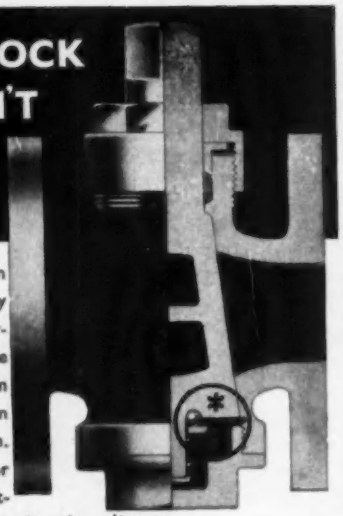

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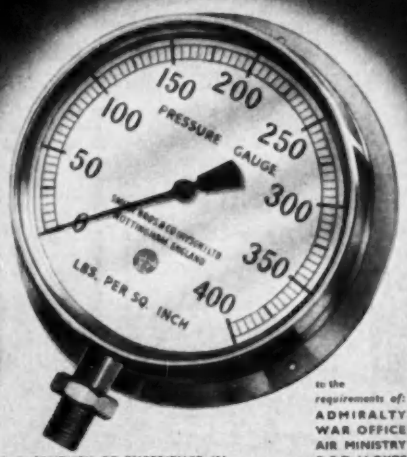

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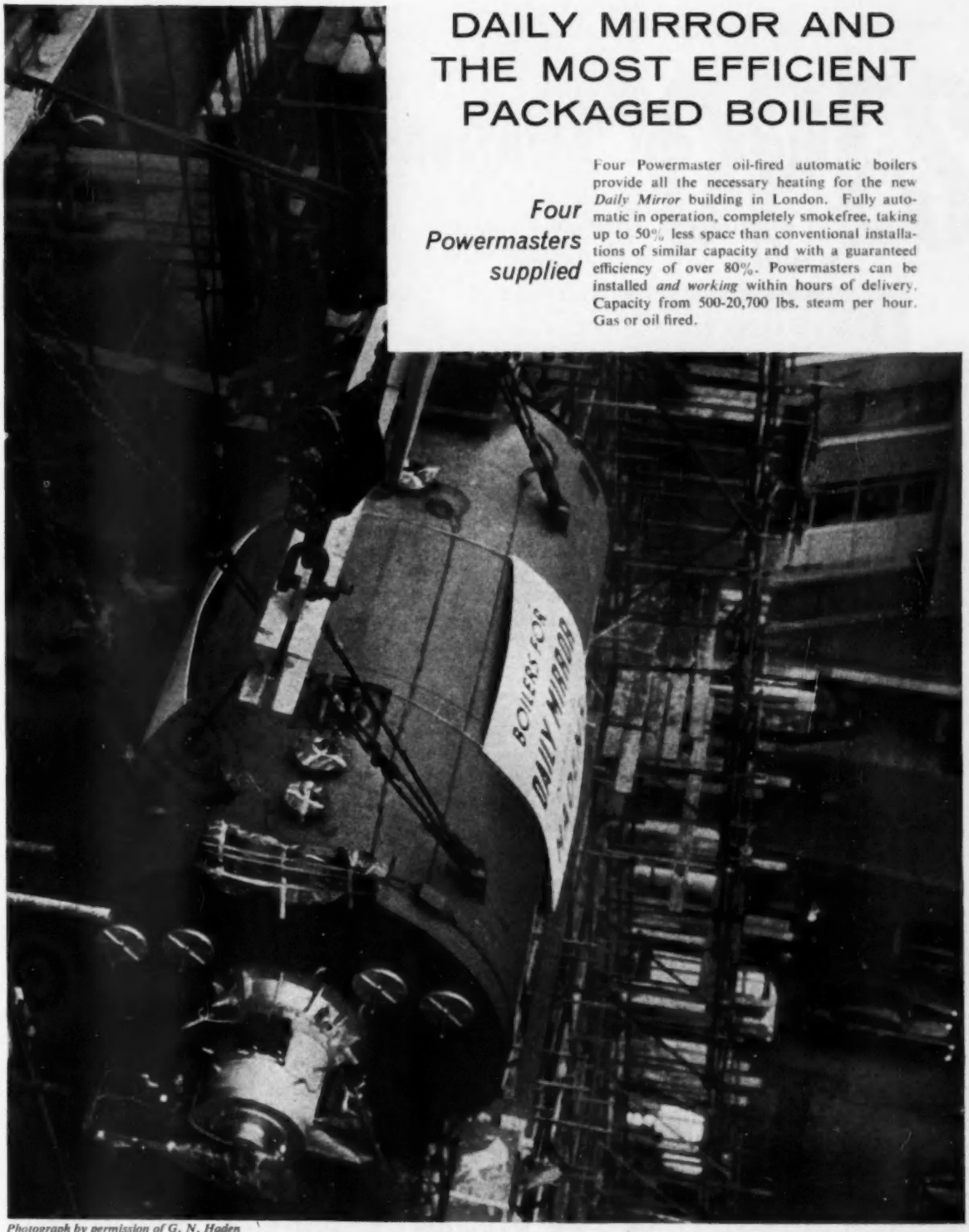

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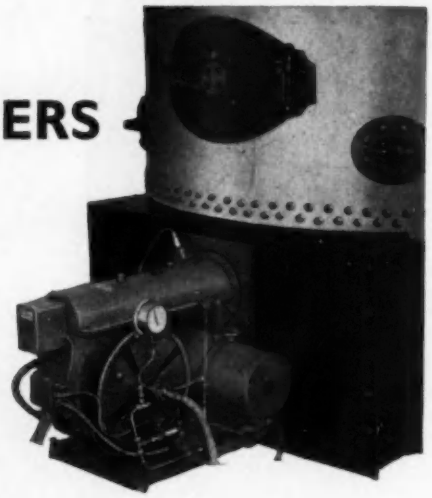

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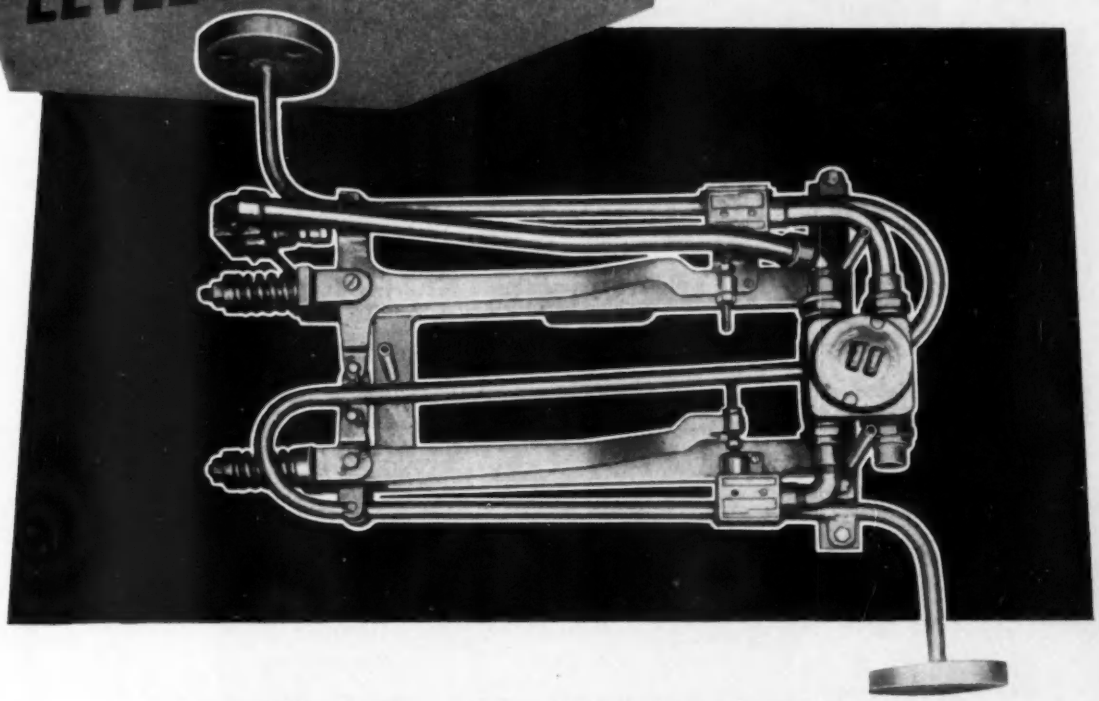

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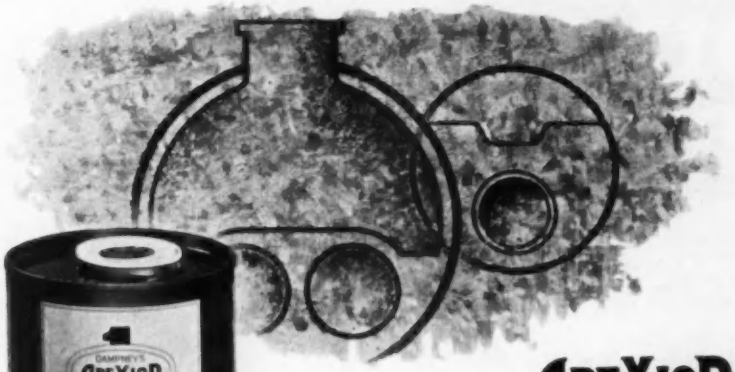

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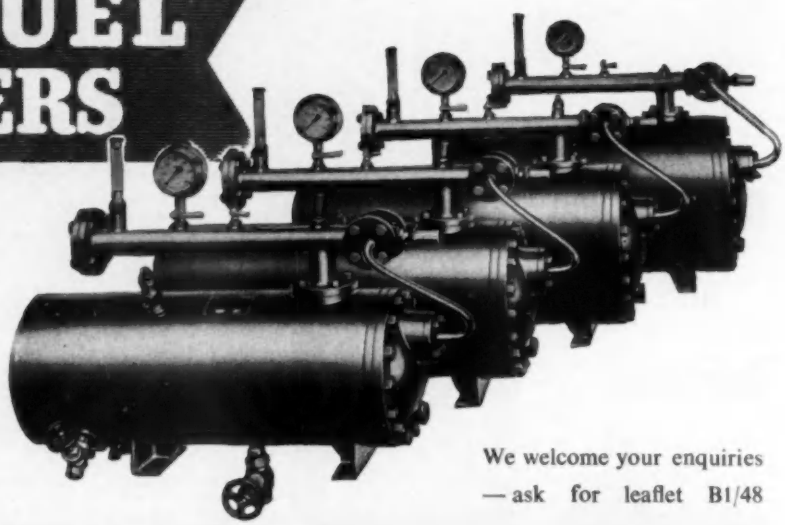

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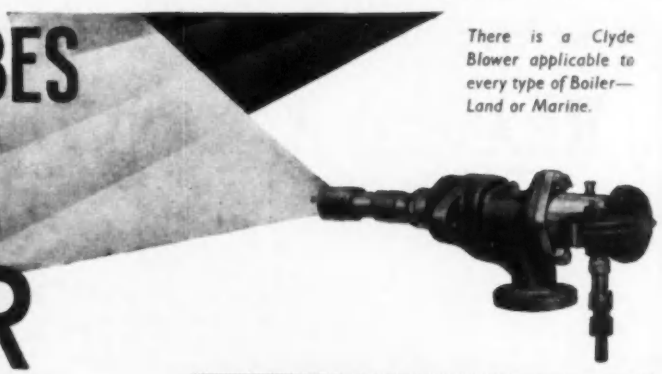

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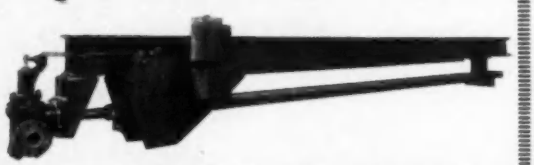

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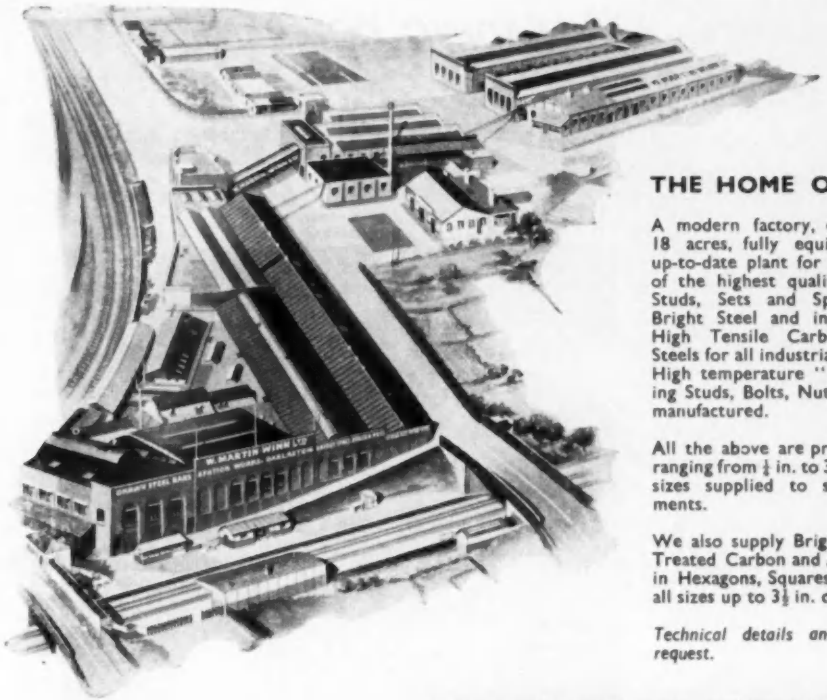

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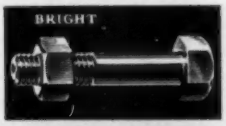

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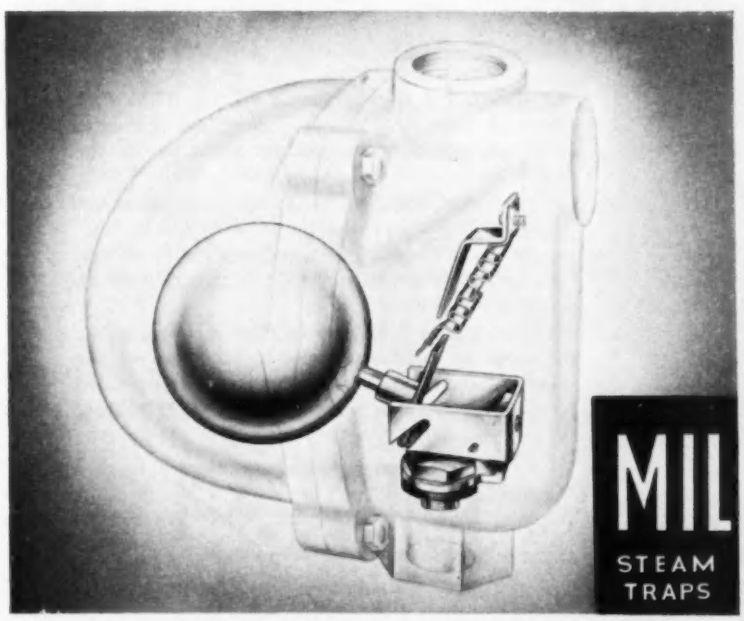

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Wickstead, C., & Co. Ltd. xxxii
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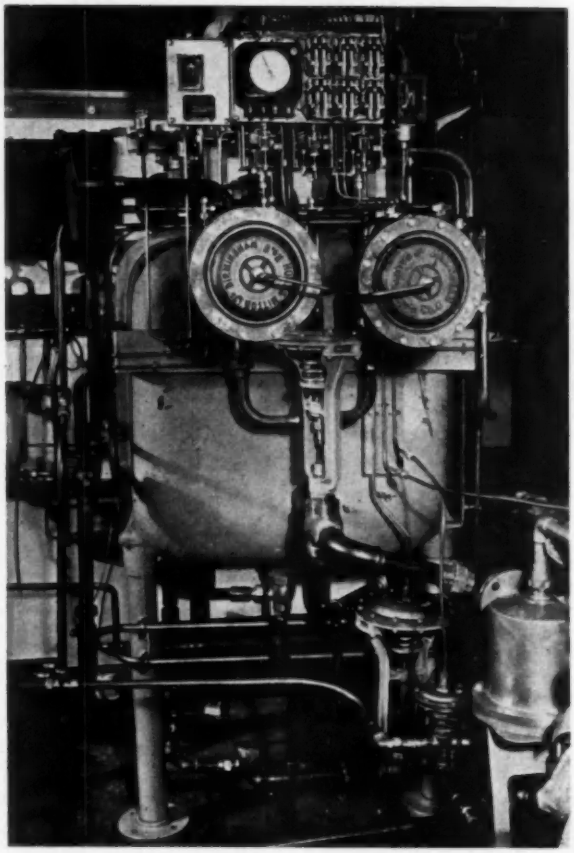

The illustration shows Hunt & Mitton diaphragm operated valves fitted to one of the Hospital Sterilisers manufactured and marketed by Messrs. James Slater & Co. Ltd. of 50/51, Wells Street, Oxford Street, London, W.1. The valves used are for steam, water and vacuum service. The vacuum duty is one of a special stringency, as the diaphragm operated valve has to give a dead-tight shut-off on absolute vacuum.

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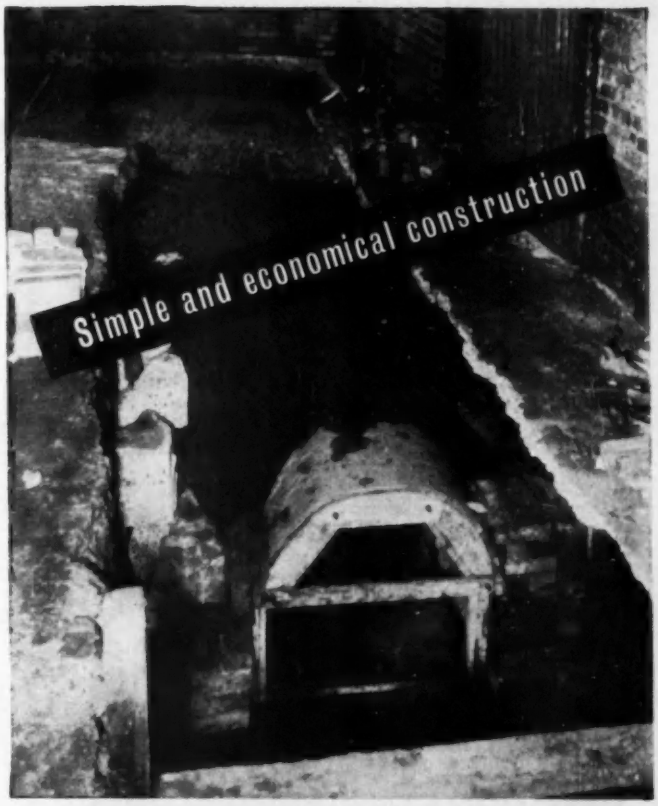

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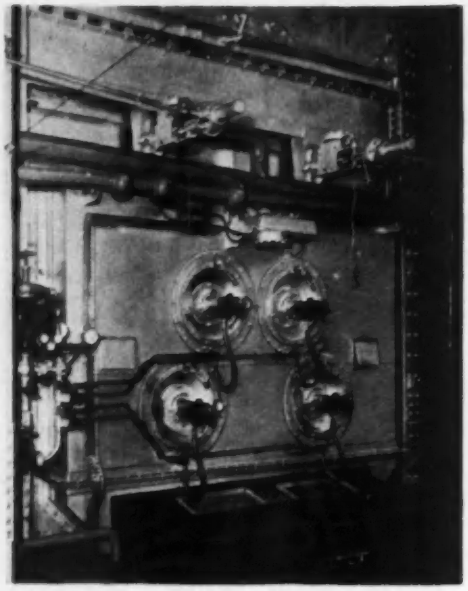

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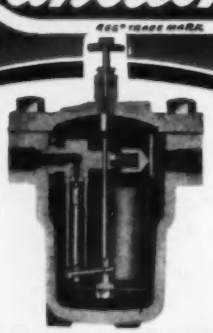

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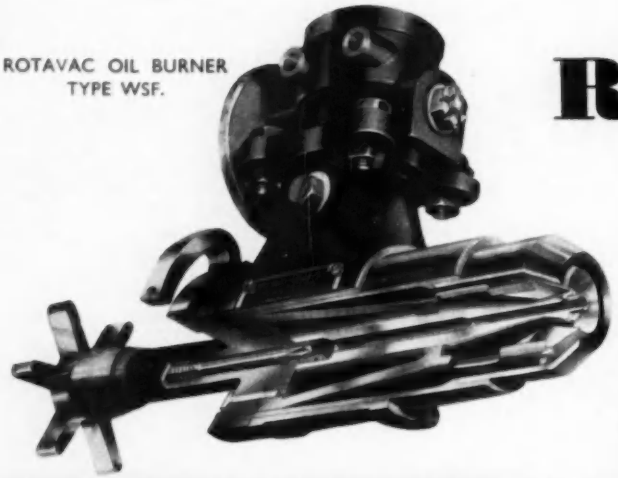

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